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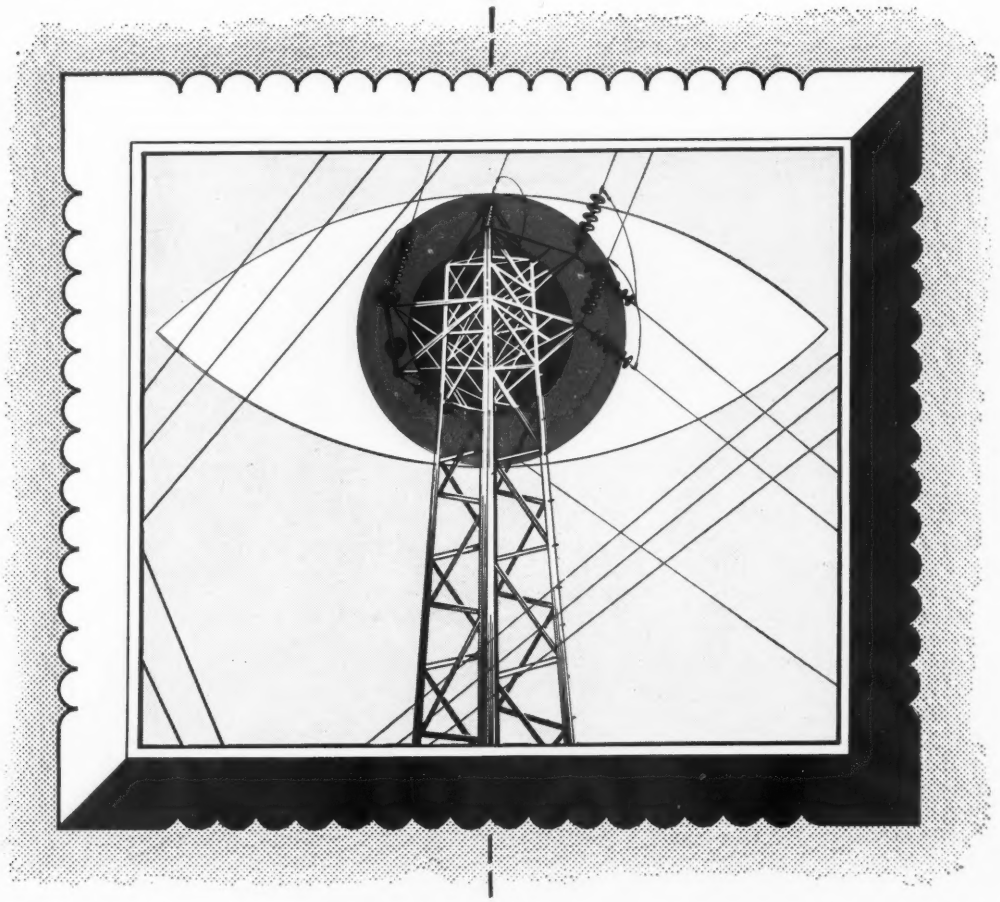

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1 APRIL 1955

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ELECTRICAL REVIEW

1 April 1955 Vol. 156 No. 13 Established 1872

Production Flow Lines

IN this issue of the *Electrical Review* is included the first of a short series of production flow line charts which we believe are unique because of the special electrical production data incorporated. They are related to production in various selected factories and workings and have been prepared by the courtesy and with the co-operation of the owners and managements of the factories in question.

Over many years we have visited all manner of production establishments where we have seen the increasing use being made of the flow line chart which is designed to give the production position at a glance. In addition to the general management and works management, which usually represented the order of things in the earlier days, we now have such officials as the production manager, the production engineer, the quantity engineer and the statistics manager, as well as many grades of liaison officers between any two or more of these managerial posts.

Every one of these people finds the simple flow line chart of the greatest help at all times when he requires mental refreshment of the general production picture with which he is associated. Nowadays, of course, it is a very rare thing to see a production machine of any sort which is not electrically driven, and in varying degrees all classes of management are vitally concerned with the power unit because of its place in the economics of the factory. Further, the electrical engineer is naturally concerned with the relationship between power and production. Yet it is a fact that we do not remember seeing one production flow line chart with the essential electrical features shown on it.

After discussions with authorities on industrial management we therefore decided that we could be of great assistance to those responsible for production and engineering management by preparing a number of flow line charts in the simplest possible manner with the electrical information related to the line. The call for simplicity dictated certain omissions which have only indirect relationship to the flow line proper—for instance picking belts, lighting, man haulage, and generally all electrical information except that which has a direct bearing on production. We hope that this simplicity will give the charts a wide appeal to engineers and management other than those directly concerned with the types of establishments depicted.

We felt that it would be a good thing to start with one of the basic industries, and so Thoresby Colliery was chosen at the suggestion of the National Coal Board because of its very high degree of electrification.

ELECTRICAL HOME RULE

Whether the separation of the South of Scotland from the British (now Central) Electricity Authority's system was really necessary or desirable was fully discussed while the Electricity Reorganization (Scotland) Bill was going through Parliament. The second reading debate was largely on party lines with the Conservatives (even English ones) approving and the Socialists (even Scottish ones) opposing; the result was 285 for and 255 against the Bill. To-day the separation becomes effective and so further argument on the point is fruitless. Everybody concerned in any way with electricity supply will now watch the activities of the new South of Scotland Electricity Board with great interest. Probably the aspect which will receive the greatest attention is the re-uniting of generation and distribution in the area. Next, the progress of rural electrification will be critically regarded, for it was urged in favour of the measure that there would be an improvement in this direction. In any event the new Board and its chairman, Mr. J. S. Pickles, will have the best wishes of the electrical industry.

ALUMINIUM TRANSMISSION TOWERS

The single-circuit aluminium towers used on the 300 kV Kemano-Kitimat transmission line in British Columbia, which are described elsewhere in this issue, represent a major development in supporting structures for high-voltage transmission lines. The decision to use aluminium for the tower construction was originally due to a shortage of galvanized steel but it was ultimately found to have so many advantages over the more conventional tower materials that a completely new design has emerged that will be of interest to transmission engineers all over the world. Apart from substantial economies over the normal type of tower, aluminium towers permit the use of very simple erection equipment, they are easily fabricated and transported and provide maximum safety during erection, inspection and maintenance. The labour requirements are very much lower than for steel towers and a satisfactory solution has been found for situations where rugged terrain and transport difficulties impose obvious limitations. The aluminium tower also affords a solution to the problem of corrosion to galvanized steel towers in polluted atmospheres. Furthermore, aluminium towers show themselves to be more suitable than steel ones where heavy snow, frost and ice deposits occur.

ELECTRICITY IN COAL MINING

In the second article in this issue of the series on "Electricity in Coal Mining" Mr. P. N. Wyke deals largely with coal face electrical equipment and touches on a few points which appear to be somewhat obscure in the electrical engineering mind in some quarters outside the mining field. It is made clear that flameproof construction and special robust construction to suit handling in the mine are two separate matters which, in the main, are dictated by the position in the mine at which the equipment is required to operate, i.e., broadly, within 300 yd of the coal face and in the "safety zone" outside this limit. But, of course, equipment for use within the 300 yd limit must be both flameproof and of extremely rugged construction. Incidentally it is worth noting what a considerable contribution was made to industry outside mining by the development of the flameproof motor. For instance, when flameproof features were called for in the oil refinery much of the technique had already been evolved. The development of the flameproof 300 kVA transformer is something which should not baffle the manufacturer indefinitely.

ENERGY FROM THE WIND

As a means of generating electricity, wind power suffers from two main disadvantages. One is its random nature, so that it cannot be relied on when perhaps most needed. Its value, including capital charges, is therefore no more than the operating cost, mainly for fuel, or a thermal station. The other drawback is the relatively small individual outputs to which aero-generators seem inherently likely to be restricted. From the particulars given by Mr. E. W. Golding in his I.E.E. paper (abstracted in this issue) the cost per kWh should be competitive with that of thermal generators, provided the latter can deal with the deficit or surplus output caused by wind vagaries. Combination with diesel-generators for supplying loads in areas remote from large main networks promise possible welcome savings in fuel oil.

RADIO AND ELECTRONIC EXPORTS

Despite the fact that some £30 million worth of radio and electronic products were exported by this country last year, there is a growing volume of imports of similar equipment from competing countries abroad. During 1954 these imports were valued at £8 million, of which the United States, Western Germany and the Netherlands contributed the bulk. About £4 million worth consisted of valves and cathode ray tubes and parts, £1·6 million radio communication and other capital equipment and nearly £2·5 million other products, mainly components and sound reproduction equipment. Imports from the Netherlands have doubled in two years while those from Western Germany have risen by 50 per cent and from the United States by 25 per cent. The situation concerning valves and cathode ray tubes has now reached a point where the United Kingdom's imports are twice as great as its exports.

REFRIGERATORS

The next in our series of illustrated surveys of domestic electrical appliances will appear in our issue of 8th April, when we shall be dealing with electric refrigerators. Information, given in tabular form, will include details of capacity, shelf area, finish, price and any other special features. In view of the continued demand for these surveys for reference purposes, orders for additional copies of the *Electrical Review* should be placed without delay. The succeeding survey (29th April) will deal with dry shavers

Aluminium Transmission Line Towers

300 kV Single-Circuit Kemano-Kitimat Line

By Dr. K. SUTTER, F. L. LAWTON and A. SOOSAAR *

THIS article, which is based on a paper by the authors published in the November, 1954, issue of the *Journal* of the Engineering Institute of Canada, deals with the design, fabrication and erection of the single-circuit aluminium towers used on the Kildala Pass section of the 300 kV Kemano-Kitimat transmission system of the Aluminum Company of Canada, Ltd., in British Columbia (see Fig. 1).

The left-hand line, in the direction of power flow, in the Kildala Pass section employs a unique type of transmission tower which is fabricated essentially from aluminium, as shown in Fig. 2. The right-hand line uses conventional lattice-type galvanized steel towers. Both lines carry the same 3,364,000 circular mils a.c.s.r. conductors. The maximum altitude reached is 5,300ft and due to the very irregular terrain, the line is far from straight. There are only a few towers on the line with tangent spans, the maximum angles in the line being 41 deg 1 min and 32 deg.

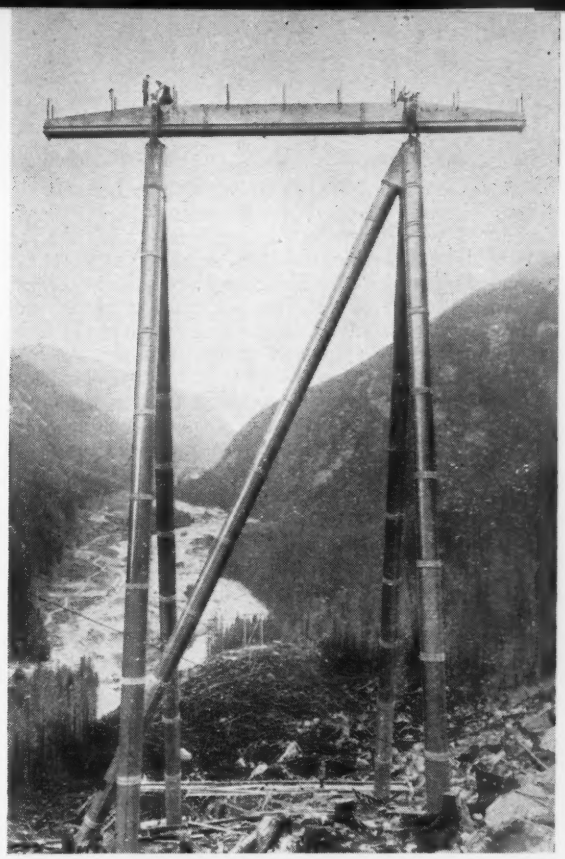

Fig. 2.—Aluminium tower under erection

In a total distance of 45,320ft the transmission circuit with aluminium towers involves a total of 34 spans, the maximum being 2,592ft. There are a total of 19 suspension and 16 strain towers, the height varying from a minimum of 74ft to a maximum of 140ft.

When it was decided to build the second of the two single circuits the Korean war made it difficult to obtain the large tonnage of galvanized steel required, and the designers turned to aluminium. As a constructional material for the fabrication of transmission line towers aluminium has many merits: it is light in weight (about one-third that of steel), easily fabricated and free from corrosion. Lightness was particularly important in the case of the Kemano-Kitimat transmission line. In the first place, the tower material had to be transported from the fabricating plant in Victoria, British Columbia, to the end of water transportation at Kemano Bay, Kildala Bay and Kitimat Arm. At these points it had to be unloaded from barges and reloaded on trucks and thence hauled and distributed to the tower sites along the transmission line route. Because of the rugged terrain, actual transporation to the various tower sites involved truck delivery in a few cases, high-line (construction cableway) delivery in many cases, and anticipated helicopter delivery in a number of instances.

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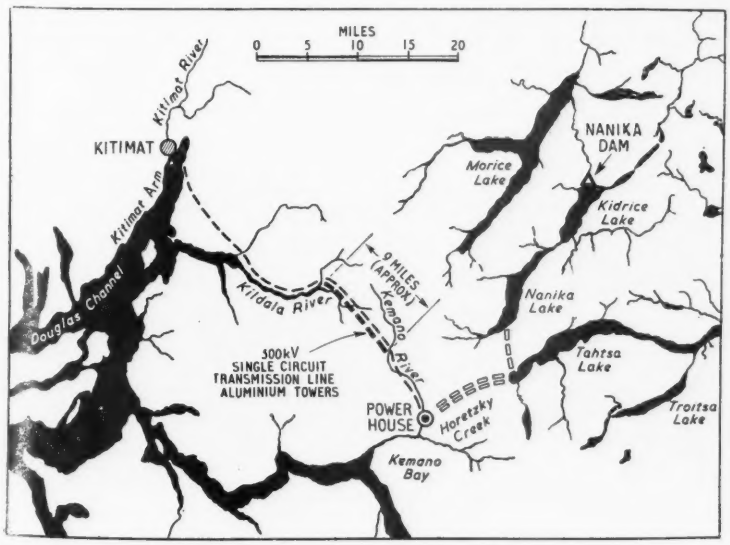


Fig. 1.—Kemano-Kitimat transmission line route

It was this anticipated transportation between truck and tower site by helicopter which established limitations on length, size and weight of tower members. Even in the case of high-line delivery, very much the same conditions existed. The anticipated one-third weight of the aluminium towers as contrasted with steel was thus an essential factor. Moreover, men engaged on tower erection cannot work so well at high altitudes as at sea level, so that the use of aluminium was advantageous from this point of view. It was possible to erect the towers by means of a simple lightweight set of manually operated erection equipment, especially applicable in the case of the aluminium towers and the light weight of aluminium also made for greater ease of fabrication in the fabricators' plant.

Galvanized steel is particularly subject to attack by corrosion during transportation by barge even in pure atmospheres such as that of the British Columbian mountains. Development of corrosion in such atmospheres is normally quite slow, but where the galvanizing is damaged by abrasion, corrosion may develop comparatively rapidly. The aluminium members of the towers which form the subject of this article are of course free from such corrosion.

An important factor associated with the design of an aluminium tower is safety of workmen, during both erection and eventual maintenance. The conventional type of steel tower, when covered with ice, snow and/or rime, provides treacherous footing at the best. On the other hand, the tubular legs of the aluminium tower, with permanently installed aluminium ladders inside, permit safe and sheltered access to the top of the towers and through the cross-arm to the conductors.

Loading Specifications

The aluminium towers were designed to meet an unusually heavy loading specification. Three factors which exercised a predominant influence were: (1) Climatic conditions due to the influence of the orographic features on the warm moisture-laden air masses moving inland from the Pacific Ocean. (2) The high current-carrying capacity conductors necessary with the heavy electrical loading dictated by the limitation in the number of circuits arising from topographical restrictions. (3) The heavy deflection angles in the line, long spans and sharp breaks in the general slope of the terrain, arising from topographical conditions.

The high current-carrying capacity required in the conductors resulted in the decision to use an a.c.s.r. conductor with an outside diameter of 2·295in, a weight of 4·77 lb/ft, an ultimate strength of 135,700 lb and an aluminium cross-section area of 3,364,000 circular mils. Consideration was given to twin conductors of smaller diameter but, after careful weighing of all factors, it was decided to use the conductor described.

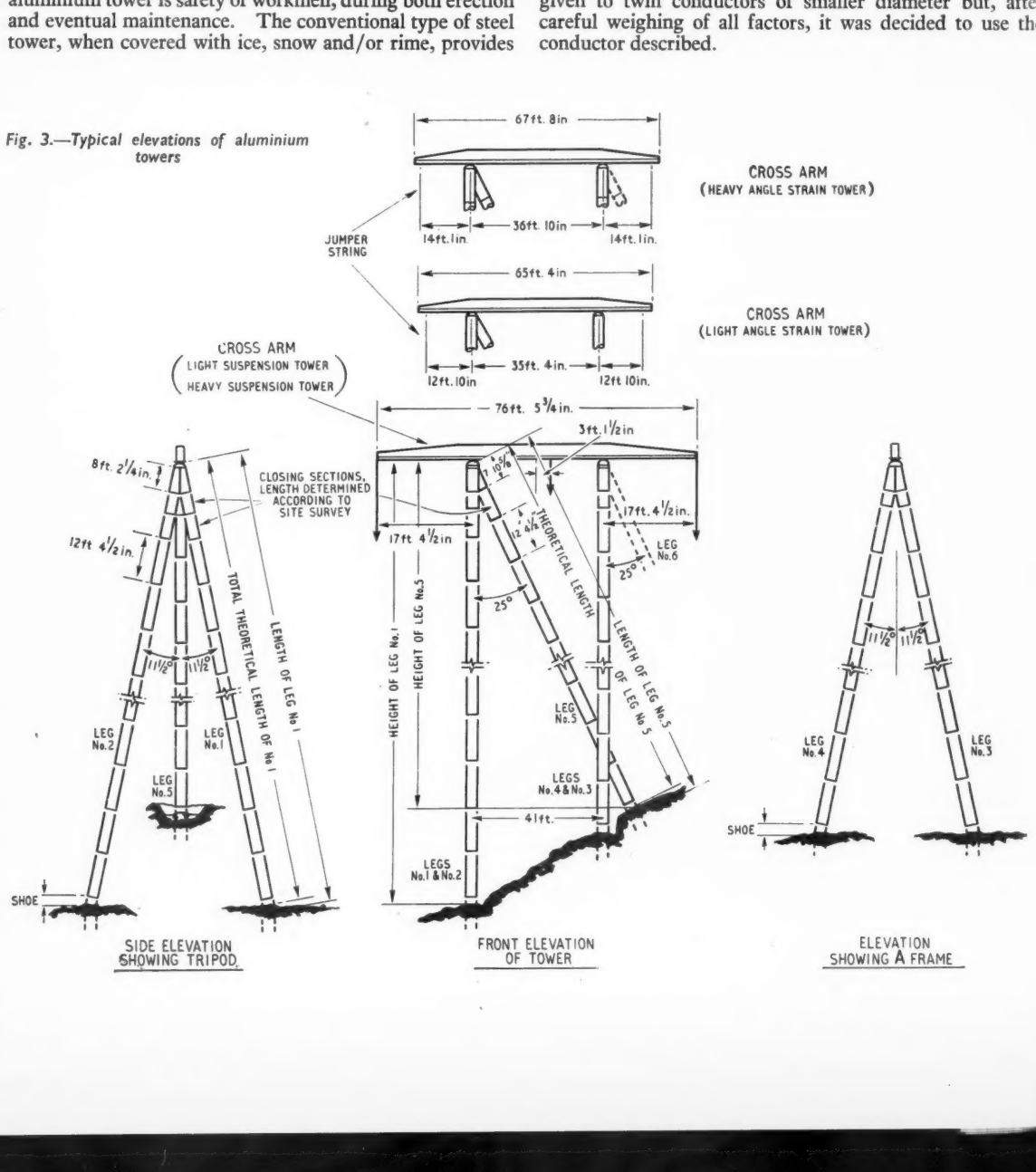


Fig. 3.—Typical elevations of aluminium towers

The loading specification decided on embraced the following requirements, as to principal loads:—

A loads: Ice load at 40 lb/ft of conductor at 0 deg F. Horizontal component of the conductor tension = 120,000 lb maximum. This may be described as a yield-point load.

B loads: 2·5in radial ice deposit on the conductor. Horizontal component of the conductor tension = 65,000 lb. Horizontal pull normal to the cross-arm, P = 10,000 lb at each point of conductor support.

B¹ loads: 60 per cent of B loads, except P = 45,000 lb at each point of conductor support.

C loads: 2·0in radial deposit of rime on the conductor combined with wind of 8 lb/sq ft. Horizontal component of the conductor tension = 35,000 lb. P = 10,000 lb at each point of conductor support.

D loads: ¾in radial deposit of ice combined with wind at 11 lb/sq ft and broken conductor. Horizontal component of conductor tension = 31,000 lb. At the suspension towers P = 22,500 lb at any one point of conductor support. At the strain towers, P = 25,000 lb at any one point of conductor support.

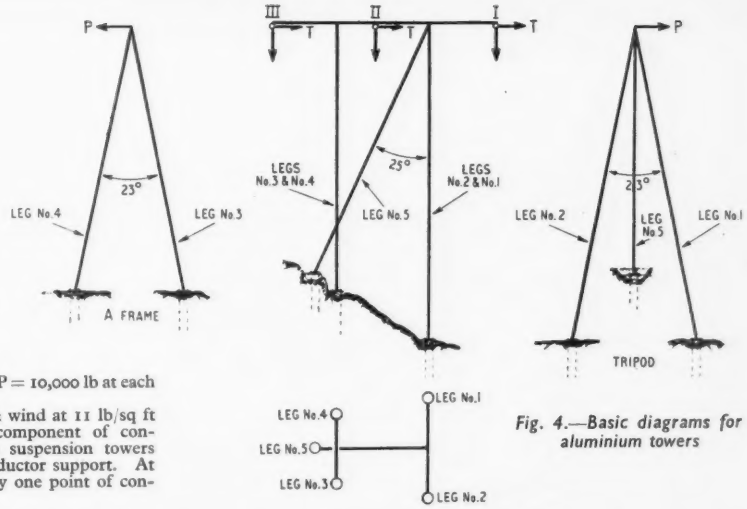


Fig. 4.—Basic diagrams for aluminium towers

The specific gravity of ice has been calculated at 0·90 and rime at 0·30. Weight of the insulators and hardware has been taken at 3,700 lb for strain towers and 1,000 lb for suspension towers. For calculating wind loads in conjunction with the above-specified C and D loads on towers, 2,000 lb per point of conductor support has been taken.

The towers were designed for the following secondary loads:—

Dead weight of tower legs and cross-arm. Wind loads at 20 lb/sq ft on circular surfaces and 40 lb/sq ft on flat surfaces. Wind loads are supposed to act in the direction of P or T (transverse) loads.

Snow loads corresponding to a loading of 6in of ice on all surfaces including the 38in diameter legs and snow-creep pressures on the legs under three categories corresponding to the depth of snow and to the slope and roughness of the ground:—(a) Normal load 33,000 lb in 20ft depth of snow, with a ground slope of 20 deg. (b) Light overload of 49,500 lb in 20ft depth of snow with a ground slope of 40 deg. (c) Heavy overload of 66,000 lb in 20ft depth of snow with a ground slope above 40 deg.

In the case of the snow loads, the 6in of ice is assumed to act simultaneously with snow-creep pressures.

General Type of Aluminium Structure

The aluminium transmission line towers can be described as braced H-frame structures, which in general use five thin-walled tubular aluminium legs of 38in overall diameter. The legs carry a box-girder-type aluminium cross-arm, as illustrated by Figs. 2 and 3. For strength and stability the tower legs are arranged as an A-frame and a tripod. The cross-arm rests freely on caps, guided by pins. The caps are bolted to the heads, in which the legs of the A-frame and the tripod are terminated. There are, however, two towers on the line, among a total of 35, where two tripods are used, the A-frame being replaced by another tripod, due to the heavy deflection angles in the line.

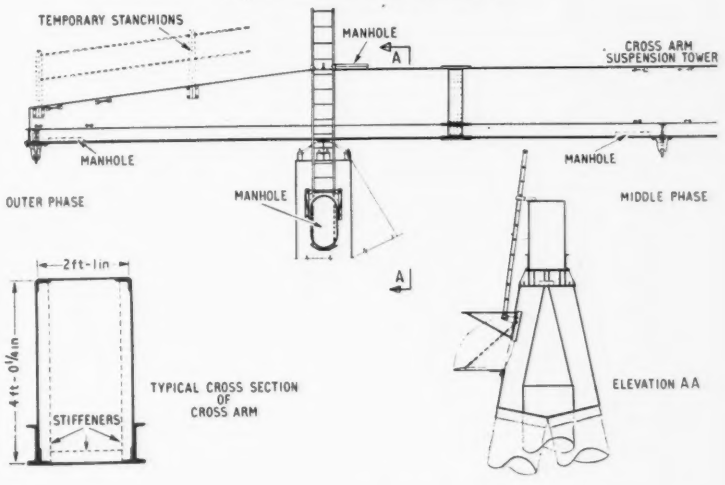
Although the towers are essentially aluminium, welded mild-steel plate was used for the shoes, leg tops and caps, all galvanized after fabrication, largely because time available did not permit necessary experimentation with, and proof testing of, these relatively complex members. Galvanized high-tensile steel bolts are used for the clamp-type inside joints of the legs, shoe and leg tops. The overall result is a line structure with relatively smooth exterior surfaces and minimum tendency to snow and rime accumulation.

The aluminium towers must carry a mechanical loading derived from the principal loads based on A, B, B¹, C and D loads as stipulated, combined with secondary loads, consisting of vertical, longitudinal and transverse components acting on the cross-arm at the three points of conductor attachment I, II, and III, with the cross-arm, a simply-supported beam, resting on the top of the A-frame and the tripod, as in Fig. 4. The geometry of the tower was based on design requirements as follows:—

(1) Minimum distance between conductors, 30ft.
(2) Maximum insulator swing for strain towers, 30 deg.
Maximum insulator swing for suspension towers, 36 deg.
(3) Clearance between conductor and tower at the point of maximum swing, 7ft 9in.
(4) Length of the insulator string for strain towers, 11ft at line angles up to 22 deg.
Length of the insulator string for strain towers, 12ft at line angles up to 45 deg.
Length of the insulator string for suspension towers, 13ft 7½in.
(5) Angles adopted at the intersection of tower members for legs Nos. 1 and 2, 23 deg.
Angles adopted at the intersection of tower members for legs Nos. 3 and 4, 23 deg.
Angles adopted at the intersection of tower members for legs Nos. 5 and 1, 2, 25 deg.

Four different cross-arms were designed for the aluminium towers, applicable with tower legs designed for

Fig. 5.—Cross-arm and accessories



the specific loading due to the supported spans and site conditions. The legs of each tower were designed for the individual principal loads and checked for secondary stresses as a result of the action of principal and secondary loads on the tower.

To provide the necessary adjustment in the height of the individual towers—that is in the length of the individual tower legs—the following provisions were made:—(1) The height of the tower (the average vertical height of the cross-arm above the ground) could be increased up to 14ft. (2) The individual length of each leg could be increased by 5 to 14ft with some few exceptions for very long legs close to 150ft in length. For example, the length of the legs for the purpose of the stress calculations would be rounded out as follows:—(a) Theoretical leg length 86 to 95ft, taken as 100ft. (b) Theoretical leg length 96 to 105ft, taken as 110ft.

In addition to the above design margins, not expressed in the usual safety factors, the following design assumptions may tend to increase the actual safety factors:—(1) No deductions for the length of the rigid leg top and the depth of the caps were made; on the other hand, no increase in the length on account of the foundation below the leg shoe was allowed. The effect of this is that the assumed buckling length of the legs is not 0·7 of the theoretical length (as valid for the fixed footing and articulated top), but the coefficient varies from 0·84 for 50ft legs to 0·74 for 150ft legs. (2) No allowance was made for the fact that, in some of the legs, the bottom section and, in some cases, also the second section, were made of aluminium plate with a greater thickness than the rest of the sections. This increment in stiffness of the leg, which would increase still more the above coefficient, was not accounted for.

While there is no special problem in accounting for items (1) and (2) in the stress calculations, it was felt that the time required to deal with them was out of proportion with possible gains in economy.

For practical reasons, the number of thicknesses of leg sections was kept to the minimum. Design was based on the assumption that the steps in value of sections would be approximately as follows:—(1) Section area, 10 per cent; (2) section modulus, 15 per cent; and (3) moment of inertia, 20 per cent.

An overall diameter of 38in was selected for all tower legs to achieve minimum weight and requisite strength, and this diameter was sufficiently close to the maximum available width of Alcan 65 S-T aluminium plate of 5ft, which permitted fabricating the leg sections with two longitudinal seams, with backing strips. The diameter of 38in permitted easy access to all parts of the legs and the adoption of leg heads and shoes of corresponding diameter and identical overall dimensions for all tower legs was convenient. Limitation of the minimum plate thickness to $\frac{3}{16}$in and the maximum to $\frac{3}{8}$in, with variation of the thickness in steps of $\frac{1}{32}$in, reduced the number of different leg sections to seven.

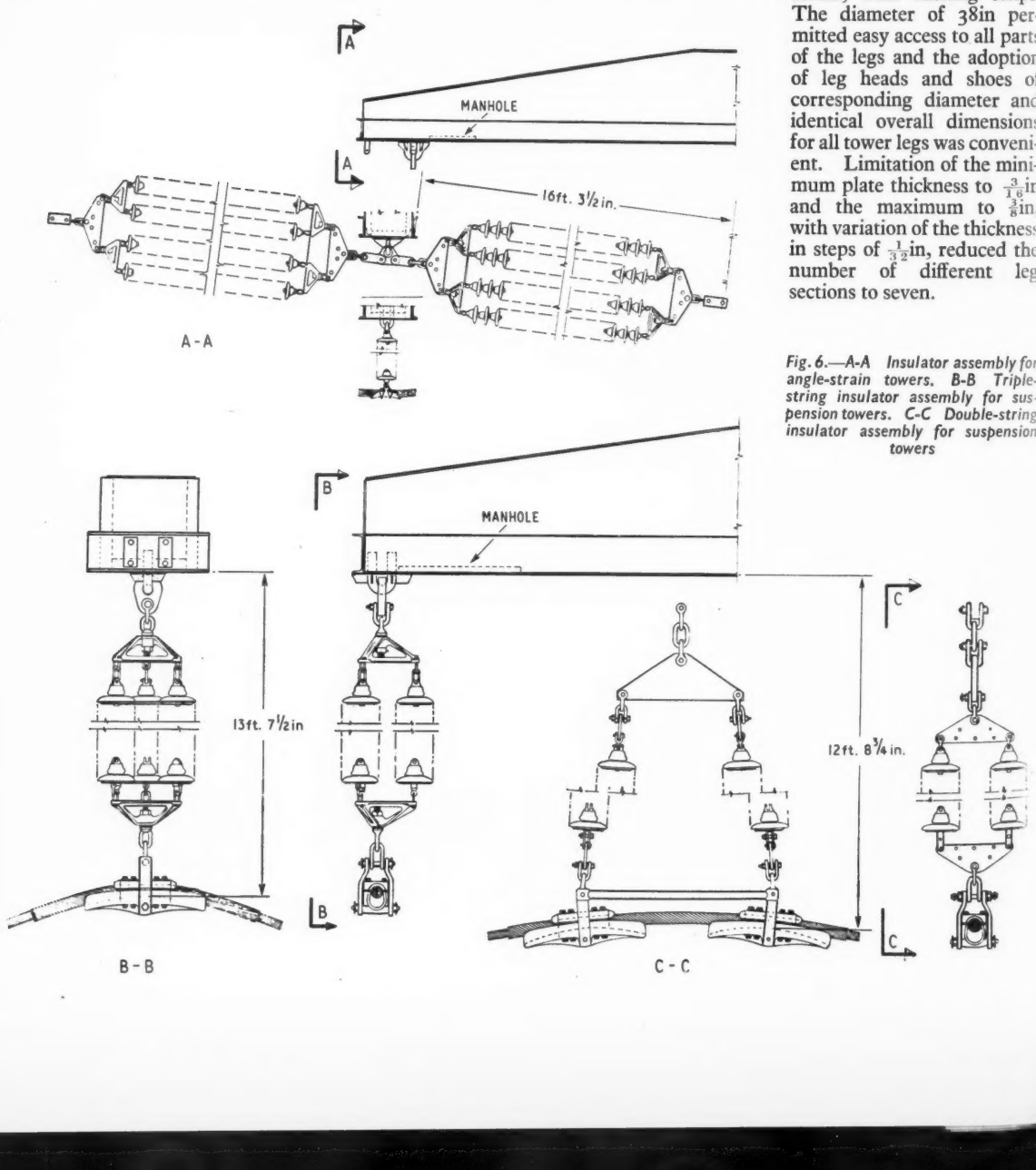


Fig. 6.—A-A Insulator assembly for angle-strain towers. B-B Triple-string insulator assembly for suspension towers. C-C Double-string insulator assembly for suspension towers

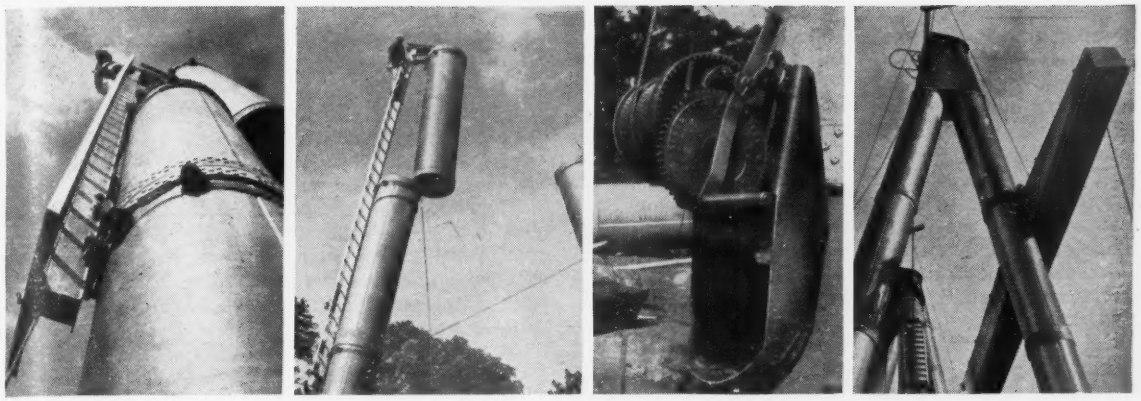


Fig. 7.—Erection methods. Left to right: Views (1) and (2) show "climbing ginpole." (3) shows 5-ton hand winch and (4) the cross-arm pulled up

The procedure employed for stress calculation embodies three general rules as given below:—(1) The principal loads were determined as exactly as possible based on weight and wind spans between towers. The weight span is, of course, the horizontal distance between the apices of the catenaries of adjacent spans, while the wind span is the average length of adjacent spans. (2) The secondary loads as well as their various combinations were determined somewhat less exactly, but the error is on the safe side. (3) The secondary stresses were calculated as exactly as possible, with influences and combinations of influences, which do not contribute in any appreciable extent to the total stress, being neglected. Finally, it should be noted that the process of stress calculation for the legs was identical for all towers.

Relative Weight of Aluminium and Steel Towers

Although most of these aluminium transmission line towers are high structures carrying unusually long and heavy spans, with extremely heavy load requirements, the average weight of the 35 towers is only 25·8 short tons. The lightest tower weighs 16·5 tons and the heaviest 33·5 tons. The weights would have been moderately lower had aluminium shoes, leg tops and caps been used. The average weight of the single-circuit steel towers used on the right-hand circuit through Kildala Pass, designed to meet the same general conditions as the aluminium towers, was 42·6 tons, the lightest weighing 34·9 tons and the heaviest 48·1 tons. Thus, the average weight of the aluminium towers was, on the average, only 60·5 per cent of that of corresponding steel towers; for the lightest towers 47·2 per cent; and for the heaviest 69·6 per cent.

The above relative weights are, in reality, no measure of the efficiency of the aluminium design as they refer to towers of different heights and of different strengths in spite of identical basic loading conditions. The aluminium strain towers are designed to withstand 45,000 lb loads as compared with only 25,000 lb for the corresponding steel towers. In addition, the aluminium towers include from 4·2 to 5·3 tons of steel, which must be deducted from both the steel and the aluminium tower weights to determine the efficiency of the aluminium used.

Relative Economy of Aluminium Towers

What is the relative economy of the aluminium towers as developed for the Kemano-Kitimat transmission system? Many component factors enter into the overall relative economy, and these are dealt with, in sequence, beginning with fabrication by the maker taken as complete and towers ready for shipment.

These are, in the case of a 114ft high aluminium tower, a total of 110 major components, exclusive of bolts and clamps. In addition some 2,220 bolts (bagged or boxed) mostly with clamps, are required. On the other hand, for the equivalent steel tower of the same height, there are over 1,120 items of steel members in addition to some 4,740 bolts and washers. Thus, the likelihood of short or overshipment by the manufacturer is considerably greater with the relatively great multiplicity of parts in the steel towers.

The loading and unloading of the much smaller number of simple components for the aluminium tower, every time transhipment is involved, requires substantially less labour as mechanical equipment can be advantageously utilized. This is particularly important where unusual means of transportation, such as high-lines and helicopters, must be used, and is important even with trucks.

The appreciably lower weight of the average aluminium tower, at 60·5 per cent of that of the steel tower, results in substantial economy in direct transportation costs by whatever form of transportation is utilized in delivery of the towers from the fabrication plant to actual tower sites.

The small number of components in the aluminium tower results in easier distribution of towers to sites with considerably smaller losses of pieces, which can so badly hamper erection, with its attendant costs. This is particularly true with snow on the ground. Much less labour is required for the distribution; it is probably in almost direct proportion to the number of components in a given tower.

The actual fabrication and erection costs of the aluminium towers for this line were considerably influenced by delays due to changes in design details throughout the entire fabrication and erection period. This was anticipated because the late decision to build the second Pass circuit as part of the first stage of the power project required the fabrication and even the erection of parts of the line before the survey exactly placing the towers of the second circuit was completed. Further, the fabrication was of a new type and shop details, methods, jigs, etc., had to be worked out while the fabrication was in progress, and even that was often held up waiting for engineering reports from the field, which first had to be translated into design drawings. It has proved impossible in the time available to segregate the proper direct costs from the indirect costs on these accounts. However, certain principles regarding costs of the aluminium towers are self evident.

Savings in erection costs secured with the aluminium towers should be substantial. They arise partly from the

simplicity of the design, with a minimum of joints; partly from the substantially smaller tonnage to be erected, labour costs varying with the weight; partly from the adaptability of the aluminium tower to erection by extremely simple erection equipment of low weight; and finally, from the confidence of workmen when maximum safety of working conditions is built into the design.

The lower weight of the aluminium tower results in important savings in erection costs for lines in mountainous country. The average aluminium tower should require about 900 man-hours of labour for erection as contrasted with 2,100 man-hours for the equivalent steel tower, a saving of 57 per cent in labour requirements. Evidence indicates that the average aluminium tower should be erected with about 650 man-hours of labour using power tools and possibly as little as one half of this with mobile cranes.

Maintenance costs are expected to be considerably lower for the aluminium towers due to ease and safety of access and optimum working safety during inspection and maintenance operations. Moreover, substantially lower maintenance costs over the life of the aluminium towers are anticipated because of freedom from corrosion.

It was expected that the smooth streamlined shapes of the aluminium tower would result in lower accumulations of snow, rime and ice than would be the case with lattice tower construction, and this was borne out by observations last winter. That is, the aluminium tower is inherently less severely loaded, with the probability that this will be reflected in lower maintenance costs.

Had the aluminium tower design not been governed by helicopter transport restrictions, the tower would have involved even fewer components, with attendant savings in cost.

Field Investigations and Observations

Erection of the aluminium towers was completed in the autumn of 1953 and the transmission line conductors were strung during the summer and autumn of 1954. The towers were, accordingly, exposed to snow, rime and ice conditions during the winter of 1953-54, during which period a crew of engineering observers was maintained at the summit of the Pass for the purpose of recording weather conditions and making observations on the various structures.

A few minor members of the aluminium towers proved to be defective in one respect or another but these instances were considered insignificant. Essentially, such faults were confined to welds in the guard-rails around the manholes at the tops of the tower legs. In a very few cases a leg section joint ring proved defective, to a degree, but careful examination traced the trouble to faulty fabrication. These have been replaced and no evidence whatever has been found to indicate that all elements of the design are other than fully adequate.

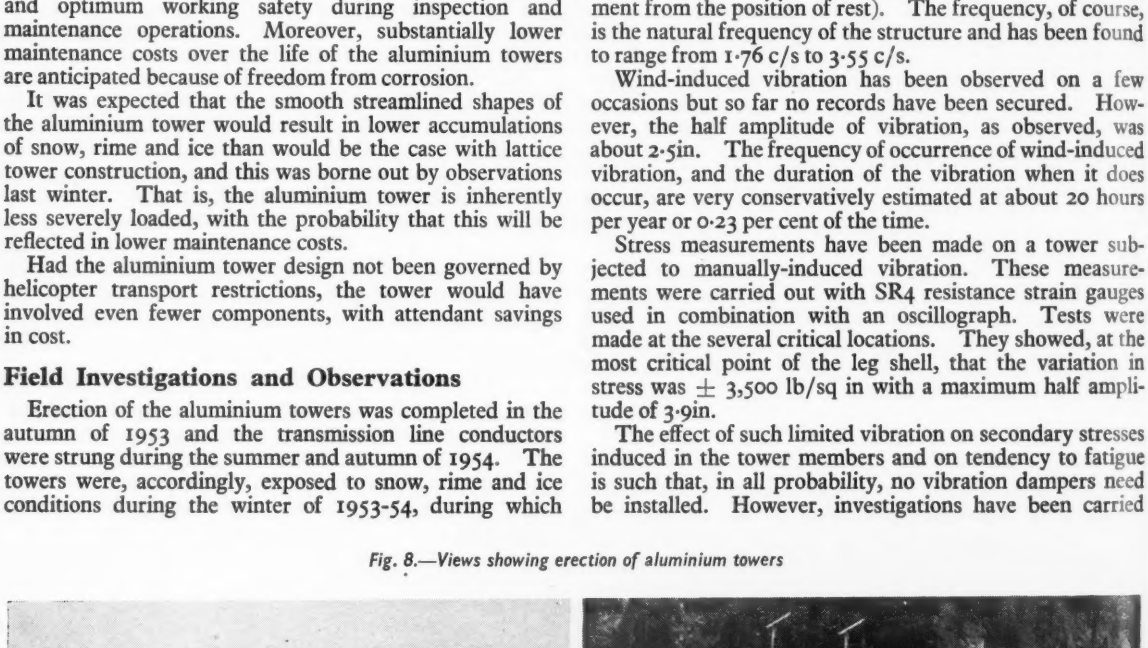
As expected, some resonant vibration of aeolian origin has occurred in the leg members of certain towers. The amplitude of such vibration as determined by manually-induced vibration was found to range up to a maximum of 4·4in half amplitude (that is, the maximum lateral movement from the position of rest). The frequency, of course, is the natural frequency of the structure and has been found to range from 1·76 c/s to 3·55 c/s.

Wind-induced vibration has been observed on a few occasions but so far no records have been secured. However, the half amplitude of vibration, as observed, was about 2·5in. The frequency of occurrence of wind-induced vibration, and the duration of the vibration when it does occur, are very conservatively estimated at about 20 hours per year or 0·23 per cent of the time.

Stress measurements have been made on a tower subjected to manually-induced vibration. These measurements were carried out with SR4 resistance strain gauges used in combination with an oscillograph. Tests were made at the several critical locations. They showed, at the most critical point of the leg shell, that the variation in stress was $\pm$ 3,500 lb/sq in with a maximum half amplitude of 3·9in.

The effect of such limited vibration on secondary stresses induced in the tower members and on tendency to fatigue is such that, in all probability, no vibration dampers need be installed. However, investigations have been carried

Fig. 8.—Views showing erection of aluminium towers



out to determine suitable types of vibration dampers a few of which have been installed to permit observations of effectiveness to be made.

Observations on the aluminium and steel towers during the winter of 1953-54 indicate that the smooth outlines of the aluminium tower result in the accumulation of considerably less snow and rime than on the steel towers. In the case of some single-circuit steel towers, as much as 48in of icy snow with a density of about 22 lb/cu ft accumulated on the secondary bracing members in the top plane of the cross-arm and resulted in bending these members. The accumulation of snow and rime on the aluminium towers was definitely very much less. It is significant that under severe winter conditions at high altitudes maintenance workmen can gain access to the cross-arm with much greater safety than in the case of the steel towers.

Conclusions

The following conclusions have been reached: —

(1) The aluminium towers employed for one circuit through Kildala Pass, on the Kemano-Kitimat transmission system, adequately meet the loading specifications under which they were designed.

(2) The aluminium tower represents substantial economies over the conventional type of steel tower. These economies arise from the 60·5 per cent average weight as contrasted with steel towers, substantially lower number of components, ease of fabrication, ease of transportation by all methods, trans-shipment and distribution. They offer very substantial economies in erection labour requirements.

(3) The aluminium towers are adaptable to the use of extremely simple erection equipment.

(4) Observations during the winter of 1953-54 indicate that aluminium towers are inherently better suited than the steel towers where heavy snow, rime and ice deposits occur.

(5) The aluminium towers provide maximum safety during erection, inspection and maintenance.

(6) The experience gained with the aluminium towers used on the Kemano-Kitimat transmission system indicates that, for loading specifications approximating more nearly the usual requirements, the design can be substantially simplified, with lower costs for fabrication and erection.

(7) The experience gained with the aluminium towers on the Kemano-Kitimat transmission system indicates that such a simplified design will result in the recommendation of aluminium transmission towers for many high-voltage lines where mountainous terrain and difficult transportation impose severe limitations.

(8) Such a simplified design of aluminium tower affords a solution to the problem of high maintenance costs incurred in polluted atmospheres which occasion high corrosion of galvanized steel structures.

NEW BOOKS

Studio Engineering for Sound Broadcasting. General editor, J. W. Godfrey. Pp. 117. Published by arrangement with the B.B.C. for *Wireless World* by Iliffe & Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 25s.

Essentially this book has been compiled for the purpose of training B.B.C. technical staff in the general principles underlying operational procedure at the Corporation's studio centres. However, broadcasting staff throughout the world, on both the engineering and non-engineering sides, will find that it contains a great deal of interest and practical value. Some of the information is specific in that it relates to equipment and procedure specially designed to meet B.B.C. requirements, but the greater part of the book dealing with the principles of audio-frequency engineering has a very general application.

The first chapter explains the development of the chain of acoustic and electrical equipment necessary in transmitting a broadcasting programme. Subsequent chapters deal with transmission quantities, acoustics for broadcasting and microphone placing, amplifier equipment, studio technical equipment, control rooms, programme circuits on Post Office lines and the broadcasting organization's own communication system.

All six authors are members of the B.B.C. engineering division and each is a specialist in his field. The technical level of the book is practical rather than academic.—R.P.

Control-System Dynamics. By Walter R. Evans. Pp. 282; figs. McGraw-Hill Publishing Co., Ltd., 95, Farringdon Street, London, E.C.4. Price 50s in the United Kingdom.

The author is the inventor of the root locus method of servo-mechanism and filter synthesis, and the main value of this book lies in his development of the principles of this method. Three out of the twelve chapters are deservedly devoted to root locus techniques. Chapter 6 introduces the method within a background of the relationship between transient and frequency responses of linear feedback systems. The next chapter containing a dozen sections is entitled "The Root Locus Method" and gives an excellent account of the theory and its usefulness and limitations in practice.

A further chapter on "Circuit Analysis" uses the author's invention in the analysis of typical systems encountered in practice. Two appendices complete the information on the root locus method; one deals with aids in the graphical sketching of loci, and the other on the use of a "Spirule" or spiral slide rule for rapid calculations.

The rest of the book deals with simple classical theory of linear systems. The mathematical approach is simple, the Laplace operator being used throughout. Several of the systems discussed are taken from the aeronautical field. An attractive feature of the book is the inclusion of a synopsis in italics preceding every section of every chapter.

In the final chapter the author deviates from linear analysis and briefly sketches the existing analytical methods for non-linear problems. The phase-plane method for analysing the transient response is described in some detail. The describing function technique (which is not mentioned by name) for ascertaining stability domains is inadequately covered. In section 12.9 it is described as a frequency response. This is not strictly true as frequency response means the response to sinusoidal inputs, whereas the describing function technique ascertains only the zero input natural stability of the non-linear system (which for purposes of analysis may have had the output disturbed initially). At the end of the book a large selection of problems is given in sections relating to the contents of the various chapters. This will be of use to serious students.

It is noted with regret that although references are given at every opportunity throughout the text, there is not one twentieth-century British reference.—J.C.W.

BOOKS RECEIVED

Remote Control by Radio. By H. Bruinsma. Second edition. Pp. 97; figs. 43. Cleaver Hume Press, Ltd., 42a, South Audley Street, London, W.1. Price 8s 6d.

Television Principles and Practice. By F. J. Camm. Second edition. Pp. 215; figs. 144. George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2. Price 25s.

SCOTTISH ELECTRICITY

New Board Takes Over

TO-DAY (1st April) responsibility for the generation and distribution of electricity in Southern Scotland passes from the British Electricity Authority (now the Central Electricity Authority) and the South West and South East Scotland Electricity Boards to a new body, the South of Scotland Electricity Board. In the Scottish Highlands generation and supply remain in the hands of the North of Scotland Hydro-Electric Board.

This separation of Southern Scotland from the English (and Welsh) electricity organization is brought about by the Electricity Reorganization (Scotland) Act passed last year. This Act transfers the functions of the Minister of Fuel and Power in Scotland in relation to electricity to the Secretary of State for Scotland. The new South of Scotland Board is to be responsible for the completion and submission of the final reports and accounts (for 1954-55) of the two Scottish Boards which it is taking over and will pay over the final balances to the Central Electricity Authority. There are also further financial adjustments between the new Board and the Central Authority, any sum due to the Authority being treated as a loan to the Board.

Provision is made in the Act for compensation to members and officers of the two superseded Boards where their rights are adversely affected by the change-over and, among other things, the Act continues relationships with the employees' negotiating and consultative organizations.

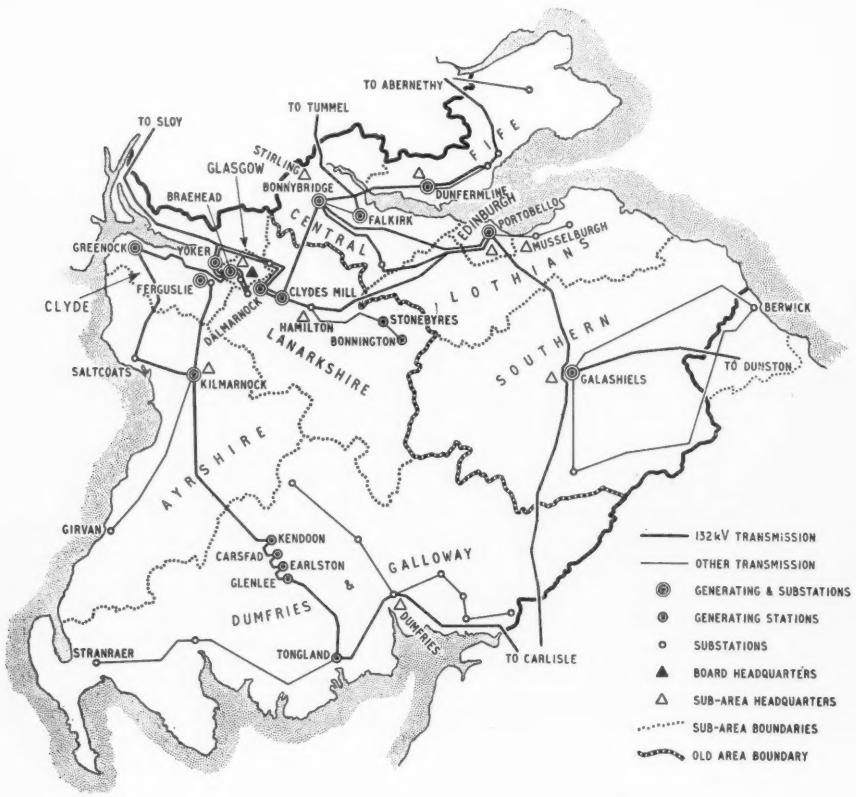
Mr. J. S. Pickles, formerly chairman of the S.W. Scotland Electricity Board, is chairman of the new Board and Sir Norman Duke (right), formerly chairman of the S.E. Scotland Board, is deputy chairman

Two of the B.E.A.'s generating divisions are involved in the take-over. At 31st December, 1954, the South West Scotland Division had 883,000 kW of plant in fourteen stations the principal of which were Clyde's Mill (217,500 kW, being extended to 277,500 kW), Braehead (200,000 kW), Dalmarnock (137,500 kW, being extended to 257,500 kW) and Yoker (100,000 kW). A new 60,000 kW station is being erected at Barony.

In the South East Scotland Division there were five stations with a total capacity of 308,625 kW. By far the largest station in this Division is Portobello (Edinburgh) whose 212,500 kW of plant is being extended. A new station, Kincardine, of 240,000 kW, is planned.

In 1953-54 the kWh sent out by the S.W. Scotland Division amounted to 3,282 million kWh and by the S.E. Scotland Division 982 million—a total of 4,264 million kWh.

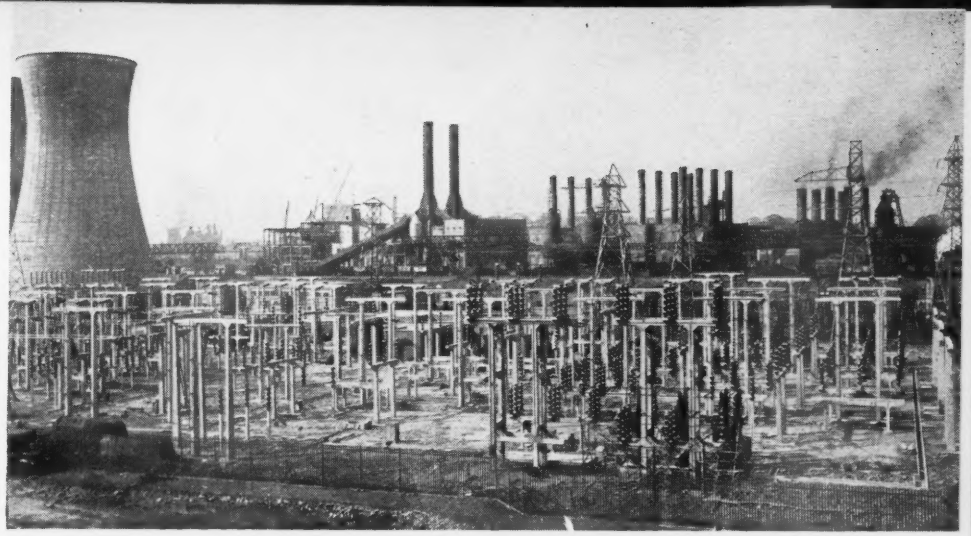
These figures may be compared with the purchases of the two Boards which totalled 4,540 million kWh in 1953-54, indicating a small importation. The Boards' consumers are classified in Table I and their sales in Table II. The S.W. Board had a maximum demand of 811,000 kW and a load factor of 45·05 per cent; the corresponding figures for the S.E. Board were



The area of the new South of Scotland Electricity Board

337,000 kW and 45·40 per cent. The latest available figures, for the twelve months ended with February last, show the sales of the S.E. Scotland Board to have been 1,488 million kWh and those of the S.W. Scotland Board 3,484 million kWh—a total of 4,972 million kWh.

The total revenue of the Boards in 1953-54 was £23·3 million (S.W., £16·4 million; S.E., £6·9 million) and the surplus £551,513 (S.W., £315,486; S.E., £236,027). At 31st March, 1954, the total capital expenditure of the two Boards was £59·1 million (S.W., £38·3 million; S.E., £20·8 million).



The largest plant in the former S.W. Scotland Division is Clyde's Mill (217,500 kW with a 60,000 kW extension in hand)

Portobello (Edinburgh) is the principal power station in the former S.E. Scotland Division (212,500 kW)

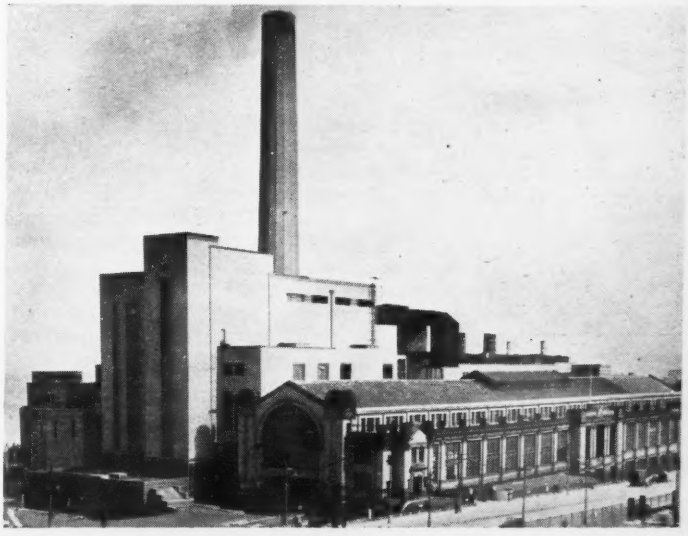


TABLE I.—ANALYSIS OF CONSUMERS, 1953-54

Class	S.W. Scotland		S.E. Scotland		Total	
	No.	%	No.	%	No.	%
Domestic	683,875	88·7	346,611	88·7	1,030,486	88·7
Commercial (inc. public lighting)...	71,839	9·3	38,130	9·8	109,969	9·5
Industrial (inc. traction)	7,897	1·1	3,212	0·8	11,109	1·0
Farm	7,160	0·9	2,615	0·7	9,775	0·8
Total	770,771	100·0	390,568	100·0	1,161,339	100·0

TABLE II.—ANALYSIS OF SALES, 1953-54

Class	S.W. Scotland		S.E. Scotland		Total	
	kWh (million)	%	kWh (million)	%	kWh (million)	%
Domestic	825	28·1	375	30·9	1,200	28·9
Commercial (inc. public lighting)...	453	15·3	229	18·9	682	16·5
Industrial (inc. traction)	1,609	54·8	586	48·4	2,195	52·9
Farm	52	1·8	21	1·8	73	1·7
Total	2,939	100·0	1,211	100·0	4,150	100·0

The final meeting of the British Electricity Authority on 10th March, 1955

Engineering in Europe

Abstracts from Foreign Technical Journals

ALTHOUGH precision potentiometers will always remain useful, they suffer from a number of drawbacks which make their replacement by more efficient set-ups imperative. Among their undesirable features is the cumbersome manual operation which is time-wasting, and also the fact that they rely on sensitive galvanometers which have to be " permanently erected " and protected against vibrations and temperature variations. The automatic potentiometers so far introduced have failed to reach the same standards of precision as the old multiple-decade (non-automatic) types. Also, fully automatic balancing is not even necessary, since the coarse balancing is carried out quickly, even by hand, and only the final (fine) balancing takes time ; the latter should therefore be rendered automatic.

The universal semi-automatic potentiometer described consists of two separate potentiometers one of which is operated manually to give a rough balance. Thus, it need only have a range of two or three decades. If the automatic potentiometer has an accuracy of only one per cent, the actual error would not exceed 0·001 per cent of the measuring range (assuming the non-automatic part to comprise three decades). A rational principle for automatic potentiometers is to replace the slide wire by a constant resistance and to obtain the balance by varying the current. This may be effected, for example, by an amplifier with negative feedback, provided its sensitivity is high enough. A suitable type was found in the photo-compensated galvanometer amplifier already widely used for high-precision measurements of small currents and voltages.

The semi-automatic potentiometer based on this principle accelerates the testing and calibrating work on measuring instruments by a factor of 2-3, enables the correction to be directly read on the potentiometer, and permits of measuring comparatively rapid processes. This universal instrument is portable and handy and costs not more than the conventional potentiometer with galvanometer.—" Semi-Automatic D.C. Potentiometers," B. A. Seliber and S. G. Rabinovich, *Elektrichestvo,* No. 11, pp. 63-68, 1954, in Russian.

Hall Generators

Despite the fact that the Hall effect has been known for about 60 years, no technical use has been made of it until now, partly because materials exhibiting a sufficiently large Hall e.m.f. were not available, or, if the Hall constant was large enough, its constancy against temperature variations was unsatisfactory. Lastly, the loading capacity of the material had to be high, i.e. its resistivity low. Such materials are now synthesized in the Siemens-Schuckert Research Laboratories in the form of intermetallic compounds, viz. indium antimonide and indium arsenide. Small slabs of these materials suitably mounted supply Hall e.m.f.s of the order of several 100 mV, this being sufficient for operating loop oscillographs, small relays, or magnetic amplifiers.

One possible application is as a multiplying element or " multiplicator " for two variable input quantities, one of which is converted into a magnetic field strength, the other into a current. The resultant Hall e.m.f. is always proportional to the product of the two input quantities. Alternatively, either magnetic field strength or current may be kept constant and the Hall e.m.f. is then proportional to the variable quantity. In the case of " multiplicators," combinations of several Hall generators with intermediate linear amplifiers enable compound multiplications to be carried out.

An obvious application of the multiplication principle is a torque-meter for d.c. motors, the flux of the motor providing the magnetic field and the armature current the current for the Hall generator. Energies liberated by phenomena of impulse character, for example, circuit-breaking by switches or fuses, can be conveniently measured by using two Hall generators, a ballistic galvanometer and a loop oscillograph. Other possible applications are measuring the air-gap flux-time curve of a d.c. machine or the field distribution in the air gap under varying load conditions. The Hall generator may for the latter purpose be mounted on the armature of the machine and the e.m.f. collected from slip rings, amplified and fed to an oscillograph.—" Applications of Hall Generators," W. Hartel, *Siemens-Z.,* Vol. 28, No. 8, pp. 376-384, September, 1954, in German.

Testing Electrical Sheets

The use of oriented-crystal transformer sheets has spread from the U.S.A. to Europe and the great technical and economic importance of these comparatively new materials compels the electrical engineer to become thoroughly acquainted with their characteristics and various new problems which their use introduces. It is true that some of these problems will affect the metallurgist, or producer, rather than the user of the sheets; even so, where the valuable characteristics of the finished product are concerned, both producer and user must be able to find out what they are, and this is the problem considered by the author. The existing methods of testing iron losses, particularly Epstein's original method and the A.S.T.M. variant of it, have to be adapted to the high flux densities used in transformer designs based on oriented-crystal sheets, and also to the far lower power loss figures of these materials.

The author also considers other test circuits, viz. that of Lloyd-Fisher, that evolved by the A.E.G. (Koppelmann) and the French set-up at the Central Laboratory of the Electrical Industries. The discussion includes all the necessary measurements, viz. that of the maximum flux density in the iron separated from the leakage flux between coil and specimen, that of the effective voltage required for the separation of the eddy current losses from the hysteresis losses, and the actual measurement of the power loss. It is found that all the methods considered are accurate enough to yield reliable results even with specimens of not more than 1 kg weight.—" Oriented-Crystal Electrical Sheets and the Adaptation of Testing Methods for Iron Losses," A. Richard, *Rev. Gen. Elect.,* Vol. 63, No. 12, pp. 713-721, December, 1954, in French.

Readers who require accurate full translations of any of the articles abstracted in this section can be put into touch with the translators who will supply them at current rates.—Editors, *Electrical Review.*

SYMMETRICAL COMPONENTS—III

The Sequence Rule

By JOHN WEBB, M.Sc. (College of Technology, Belfast)

IT is often convenient to resolve the phase impedances Z_R, Z_Y and Z_B, into symmetrical components of impedance. Such component impedances may be difficult to interpret on a physical basis, but they are useful in developing further relationships.

They are derived in exactly the same manner as that in which the components of voltage have already been derived.

Thus

$$Z_{R1} = 1/3\,(Z_R + aZ_Y + a^2Z_B)$$
$$Z_{R2} = 1/3\,(Z_R + a^2Z_Y + aZ_B)$$
$$Z_{R0} = 1/3\,(Z_R + Z_Y + Z_B)$$

These expressions should not be confused with the impedances offered to the various sequence currents. The impedance, of, say, an alternator, to negative sequence current is a quantity which may be interpreted as the ratio of negative sequence voltage to negative sequence currents.

This ratio is analytically indeterminate because of the complicated effect of armature reaction. It must therefore be obtained experimentally. The expressions above then, are the symmetrical components of a three-phase load and are no more than mathematical expressions whereas the impedance to a particular sequence current is a quantity of some physical significance.

To examine the relationship between component voltages, currents and impedances let V_R be the voltage drop across the red phase, I_R the red phase current and Z_R the red phase impedance.

Thus $V_R = I_R Z_R$

or $(V_{R1} + V_{R2} + V_{R0}) = (I_{R1} + I_{R2} + I_{R0})(Z_{R1} + Z_{R2} + Z_{R0})$

This product yields nine terms, viz.:—

$$I_{R1}Z_{R1} + I_{R1}Z_{R2} + I_{R1}Z_{R0} + I_{R2}Z_{R1} + I_{R2}Z_{R2} + I_{R2}Z_{R0} + I_{R0}Z_{R1} + I_{R0}Z_{R2} + I_{R0}Z_{R0}$$

These terms require to be grouped so as to give the components of V_R.

The correct groupings are

$$\left.\begin{aligned} V_{R1} &= I_{R1}Z_{R0} + I_{R2}Z_{R2} + I_{R0}Z_{R1} \\ V_{R2} &= I_{R1}Z_{R1} + I_{R2}Z_{R0} + I_{R0}Z_{R2} \\ V_{R0} &= I_{R1}Z_{R2} + I_{R2}Z_{R1} + I_{R0}Z_{R0} \end{aligned}\right\} \quad .. \quad .. \quad (5)$$

The sequence rule is:—

The product IZ belongs to the same voltage drop sequence as is obtained by adding the sequence suffixes of I and Z.

For example $I_{R2}Z_{R0}$ belongs to voltage drop sequence $2 + 0$, i.e. 2, the negative sequence.

Since there are only three orders, viz., 0, 1 and 2, then $2 + 2 = 4 = 1$, $2 + 1 = 3 = 0$, etc. The other components of voltage drop will be

$$V_{Y1} = I_{Y1}Z_{Y0} + I_{Y2}Z_{Y2} + I_{Y0}Z_{Y1}$$
$$V_{Y2} = I_{Y1}Z_{Y1} + I_{Y2}Z_{Y0} + I_{Y0}Z_{Y2}$$
$$V_{Y0} = I_{Y1}Z_{Y2} + I_{Y2}Z_{Y1} + I_{Y0}Z_{Y0}$$
$$V_{B1} = I_{B1}Z_{B0} + I_{B2}Z_{B2} + I_{B0}Z_{B1}$$
$$V_{B2} = I_{B1}Z_{B1} + I_{B2}Z_{B0} + I_{B0}Z_{B2}$$
$$V_{B0} = I_{B1}Z_{B2} + I_{B2}Z_{B1} + I_{B0}Z_{B0}$$

These are obtained by symmetry with expression 5. The voltages V_{R1} V_{Y1} and V_{B1} comprise the positive sequence components of V_R V_Y and V_B. If the expressions for these component voltages are correct then we should be able to apply the test $V_{Y1} = a^2V_{R1}$ or $V_{R1} = aV_{Y1}$ Thus

$$\begin{aligned} V_{R1} &= a\{I_{Y1}Z_{Y0} + I_{Y2}Z_{Y2} + I_{Y0}Z_{Y1}\} \\ &= a\{a^2I_{R1}Z_{R0} + aI_{R2}aZ_{R2} + I_{R0}a^2Z_{R1}\} \\ &= a^3I_{R1}Z_{R0} + a^3I_{R2}Z_{R2} + a^3I_{R0}Z_{R1} \\ &= I_{R1}Z_{R0} + I_{R2}Z_{R2} + I_{R0}Z_{R1} \end{aligned}$$

In the same way all the component voltage drops may be investigated to prove that they do in fact belong to orthodox symmetrical component systems.

At this stage it is useful to attempt a problem in which the relationships, which have already been developed, are used. A phase sequence test can be made by connecting two lamps and a choke in star, to the three supply lines in which it is required to know the phase sequence. It will be assumed that the lamps can be represented by two pure resistances of 500 ohms each and that the choke is a pure reactance of 500 ohms, and is connected in the yellow phase.

It will be assumed that the line voltages are each equal to 500 V and that the sequence is RY–YB–BR.

The component impedances will be

$$\begin{aligned} Z_{R0} &= 1/3\,(500 + 500\,/90^\circ + 500) \\ &= 372{\cdot}67\,/26^\circ\,34' \text{ ohms} \\ Z_{R1} &= 1/3\,(500 + 500\,/210^\circ + 500\,/240^\circ) \\ &= 1/3\,(500 - 433 - 250 - j\,250 - j\,433) \\ &= -61 - j\,227{\cdot}7 \\ &= 236\,/255^\circ \text{ ohms} \\ Z_{R2} &= 1/3\,(500 + 500\,/330^\circ + 500\,/120^\circ) \\ &= 1/3\,(500 + 433 - 250 - j\,250 + j\,433) \\ &= 227{\cdot}7 + j\,61 \\ &= 236\,/15^\circ \text{ ohms} \end{aligned}$$

The line voltages are

$$V_{RY} = 500\,/0^\circ \text{ volts}$$
$$V_{YB} = 500\,/-120^\circ \text{ volts}$$
$$V_{BR} = 500\,/120 \text{ volts}$$

The symmetrical components of line voltage are then

$$\begin{aligned} V_{RY1} &= 1/3\,(500 + 500 + 500) \\ &= 500\,/0^\circ \text{ Volts} \\ V_{RY2} &= 1/3\,(500 + 500\,/120^\circ + 500\,/240^\circ) \\ &= 0 \\ V_{RY0} &= 1/3\,(500 + 500\,/-120^\circ + 500\,/120^\circ) \\ &= 0 \end{aligned}$$

The following are the relationships between component phase and component line voltages.

$$V_{R1} - V_{Y1} = V_{RY1}$$
$$V_{R1} - V_{R1}\,/-120^\circ = V_{RY1}$$
$$V_{R1}\{1 - (-0{\cdot}5 - j\,0{\cdot}866)\} = V_{RY1}$$
$$V_{R1}\,(1{\cdot}5 + j\,0{\cdot}866) = V_{RY1}$$
$$V_{R1} = \frac{V_{RY1}}{\sqrt{3}}\,/-30^\circ$$

Similarly $V_{R2} = \dfrac{V_{RY2}}{\sqrt{3}}\,/30^\circ$

NOTE.—The negative and zero sequence components of a balanced set of vectors are both zero.

Consequently in the example under consideration

$$V_{R_1} = \frac{500}{\sqrt{3}} /-30^\circ$$
$$= 288 /-30 \text{ volts}$$

and $V_{R_2} = 0$

Using expression 5

viz., $V_{R_1} = I_{R_1} Z_{R_0} + I_{R_2} Z_{R_2} + I_{R_0} Z_{R_1}$

we obtain

$$288 /-30^\circ = 372{\cdot}7 /26^\circ 34' \, I_{R_1} + 236 /15^\circ \, I_{R_2} + 0$$

Since the sum of the line currents in a three-wire three-phase system is zero then I_{R_0} must be zero in this instance.

Similarly using the expression for V_{R_2} we obtain

$$0 = 236 /255^\circ \, I_{R_1} + 372{\cdot}7 /26^\circ 34' \, I_{R_2}$$

from which

$$I_{R_2} = -\frac{236 /255^\circ}{372{\cdot}7 /26^\circ 34'} I_{R_1}$$
$$= 0{\cdot}633 /48^\circ 26' \, I_{R_1} \text{ amps.}$$

This value is now substituted in the expression for V_{R_1}

$$288 /-30 = 372{\cdot}7 /26^\circ 34' \, I_{R_1} + 0{\cdot}633 /48^\circ 26' \times 236 /15^\circ \, I_{R_1}$$
$$= I_{R_1} (333{\cdot}3 + j\,166{\cdot}7 + 67 + j\,133{\cdot}5)$$
$$= 500 /36^\circ 52' \, I_{R_1}$$

therefore $I_{R_1} = \frac{288}{500} /-66^\circ 52'$

$$= 0{\cdot}576 /-66^\circ 52' \text{ amps.}$$

Also $I_{R_2} = 0{\cdot}576 /-66^\circ 52' \times 0{\cdot}633 /48^\circ 26'$

$$= 0{\cdot}3645 /-18^\circ 26' \text{ amps.}$$

therefore $I_R = 0{\cdot}576 /-66^\circ 52' + 0{\cdot}3645 /-18^\circ 26'$

$$= 0{\cdot}5735 - j\,0{\cdot}6515$$
$$= 0{\cdot}869 /-48^\circ 42' \text{ amps.}$$

The current through the lamp in the blue phase

$$I_B = I_{B_1} + I_{B_2}$$
$$= aI_{R_1} + a^2 I_{R_2}$$
$$= 0{\cdot}576 /53^\circ 8' + 0{\cdot}3645 /221^\circ 34'$$
$$= 0{\cdot}0735 + j\,0{\cdot}219$$
$$= 0{\cdot}2318 /71^\circ 27' \text{ amps.}$$

In the same way the current through the choke is found, thus, $I_Y = I_{Y_1} + I_{Y_2}$

$$= a^2 I_{R_1} + aI_{R_2}$$
$$= 0{\cdot}576 /173^\circ 8' + 0{\cdot}3645 /101^\circ 34'$$
$$= -0{\cdot}6449 + j\,0{\cdot}426$$
$$= 0{\cdot}774 /146^\circ 30' \text{ amps.}$$

The results are summarized in Fig. 6.

The red lamp will therefore be bright and the blue lamp dim for a phase sequence R–Y–B.

For the reversed sequence R–B–Y the red lamp will be dim and the blue lamp bright.

This could be proved by a calculation along similar lines by specifying the line voltages as

$V_{RY} = 500 /0^\circ$

$V_{YB} = 500 /120^\circ$

$V_{BR} = 500 /-120^\circ$

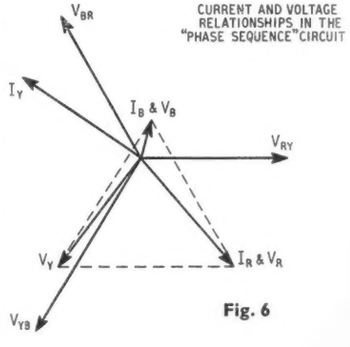


Fig. 6

CONCRETE TESTING

UNTIL recent years the only way in which the physical characteristics of concrete and the changes brought about by ageing and other causes could be determined was by tests to destruction carried out on specially prepared specimens. These tests were useful but not entirely satisfactory because of variations in compacting conditions in specimens and structure. The need of the engineer for a non-destructive technique for concrete testing was met by the development, at the Road Research Laboratory, Department of Scientific and Industrial Research, of the ultrasonic pulse method, equipment for which is now manufactured in this country and marketed both here and abroad. An extensive investigation of the scope of the method is described in Road Research Technical Paper No. 34, "Testing Concrete by an Ultrasonic Pulse Technique," by R. Jones, B.Sc., Ph.D., and E. N. Gatfield (H.M. Stationery Office, price 2s 6d net).

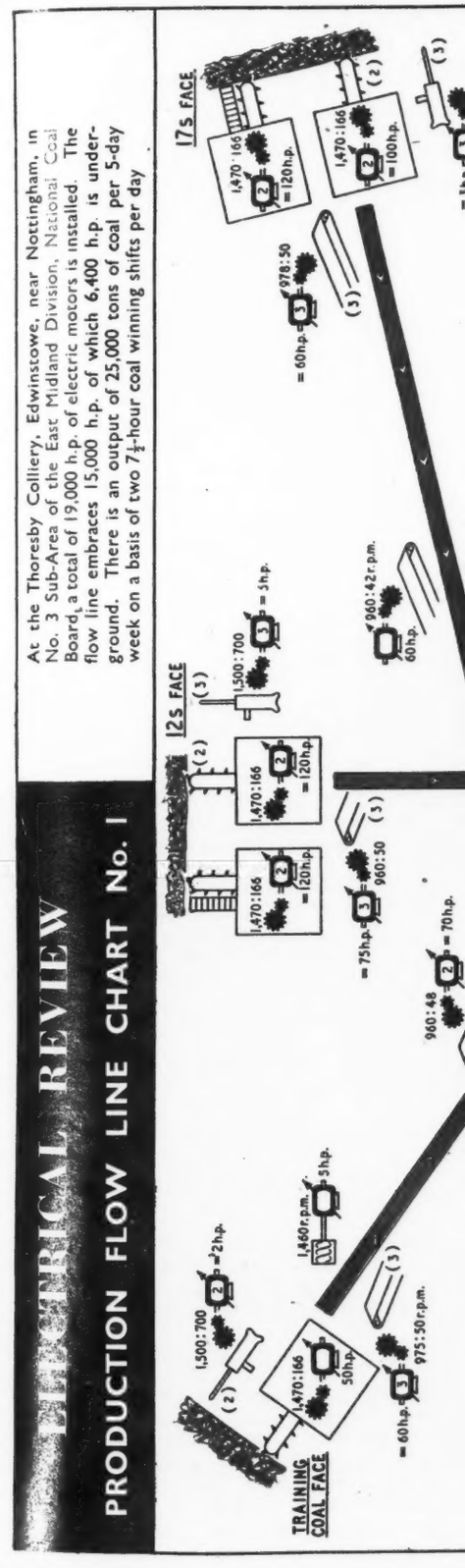
The ultrasonic equipment uses two transducers placed on opposite faces of the concrete being tested. Pulses are timed electrically as they pass from one transducer to the other through the concrete, and the time of transmission indicates the characteristics of the concrete and the presence of internal cracks. A study has been made of the various factors, such as age, nature and proportions of the mix, moisture content, the presence of mild-steel reinforcing bars, and so on, on the transit time of the pulses between the transducers. The effect of these factors on the ultrasonic testing technique is discussed.

One of the advantages of this method of testing is that it can be applied to concrete *in situ* and it can detect any deterioration due to weakness or poor compaction. The technique can be applied, for instance, to determine the strength of such structures as pre-stressed units and reservoir walls. Examples are given of the practical applications of the method. The use of the ultrasonic technique for testing road surfaces is also dealt with. This involves the use of reflection, the sound pulses being thrown back by the lower boundary of the slab. The method can only be used satisfactorily when the underside of the slab is relatively smooth.

Combustion Problems

AT a Press conference held by the Institution of Mechanical Engineers last week the arrangements being made for a joint conference on combustion problems with the American Society of Mechanical Engineers were outlined. The conference is to be held in Boston from 15th to 17th June and repeated in London from 25th to 27th October this year. In all, forty papers are to be presented in five sections: general, boilers, industrial furnaces, internal combustion engines, and gas turbines. These will be available in advance and the proceedings at the actual conference will take the form of a brief outline of the salient points brought out in each paper, by reporters, the bulk of the time being given over to discussion. Only those papers presented in the first and general session will be read fully. Seventeen Institutions and Societies in the United Kingdom are supporting the conference, which in London will be held in the great hall of the Institution of Civil Engineers.

Professor O. A. Saunders, chairman of the organizing committee, stressed that the important aspect of the conference was the practical application of theory. Copies of papers were expected to be available at the end of April from the Institution of Mechanical Engineers.


ELECTRICAL REVIEW
PRODUCTION FLOW LINE CHART No. 1—COAL MINING
PRODUCTION FLOW LINE CHART No. 1
At the Thoresby Colliery, Edwinstowe, near Nottingham, in No. 3 Sub-Area of the East Midland Division, National Coal Board, a total of 19,000 h.p. of electric motors is installed. The flow line embraces 15,000 h.p. of which 6,400 h.p. is underground. There is an output of 25,000 tons of coal per 5-day week on a basis of two 7½-hour coal winning shifts per day
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12s FACE
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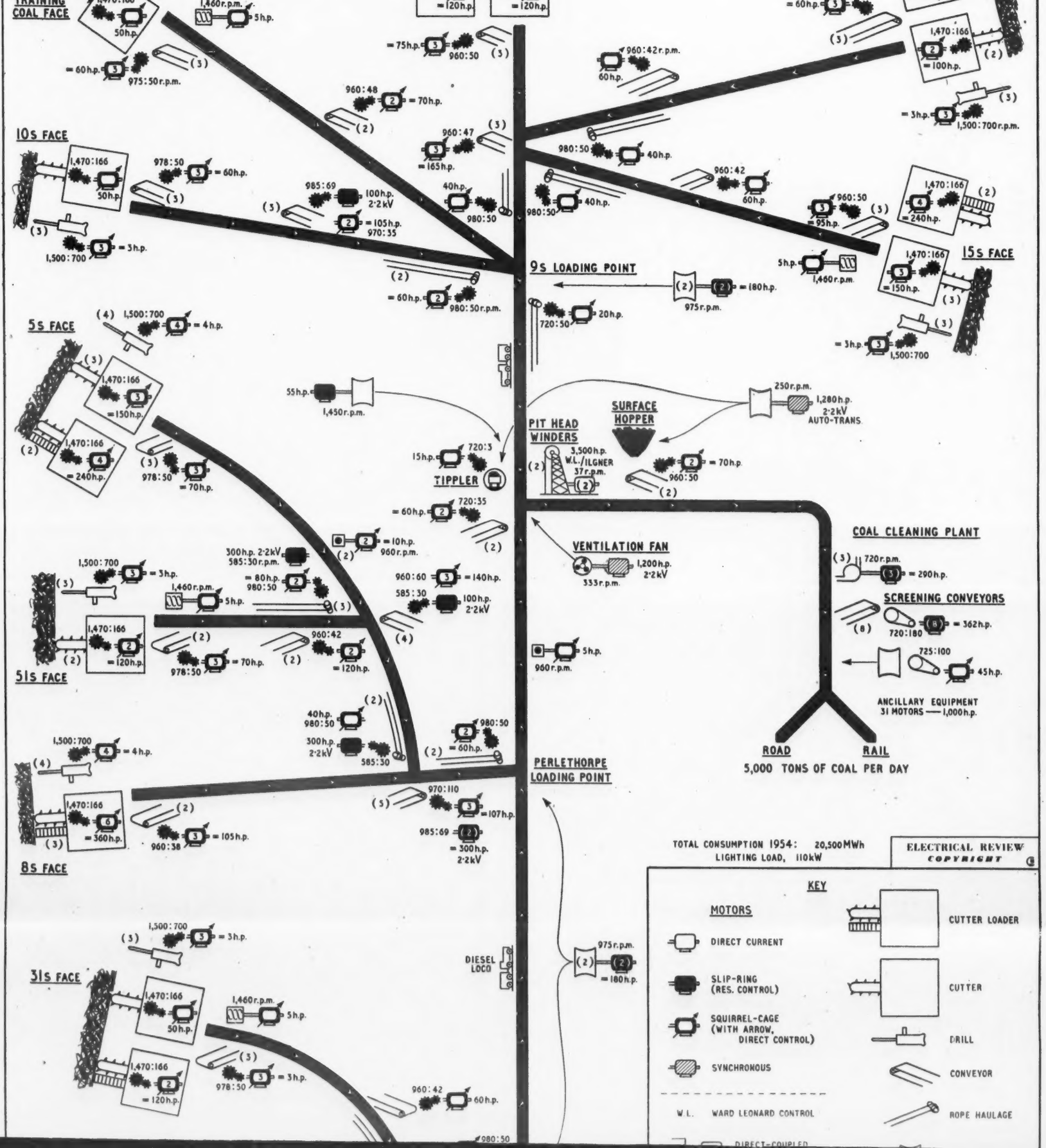
= 75 h.p.
= 70 h.p.
= 2 h.p.
= 50 h.p.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PIT HEAD WINDERS
SURFACE HOPPER
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COAL CLEANING PLANT
SCREENING CONVEYORS
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PERLETHORPE LOADING POINT
DIESEL LOCO
TOTAL CONSUMPTION 1954: 20,500MWh
LIGHTING LOAD, 110kW
ELECTRICAL REVIEW
COPYRIGHT
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DIRECT CURRENT
SLIP-RING (RES. CONTROL)
SQUIRREL-CAGE (WITH ARROW, DIRECT CONTROL)
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W.L. WARD LEONARD CONTROL
CUTTER LOADER
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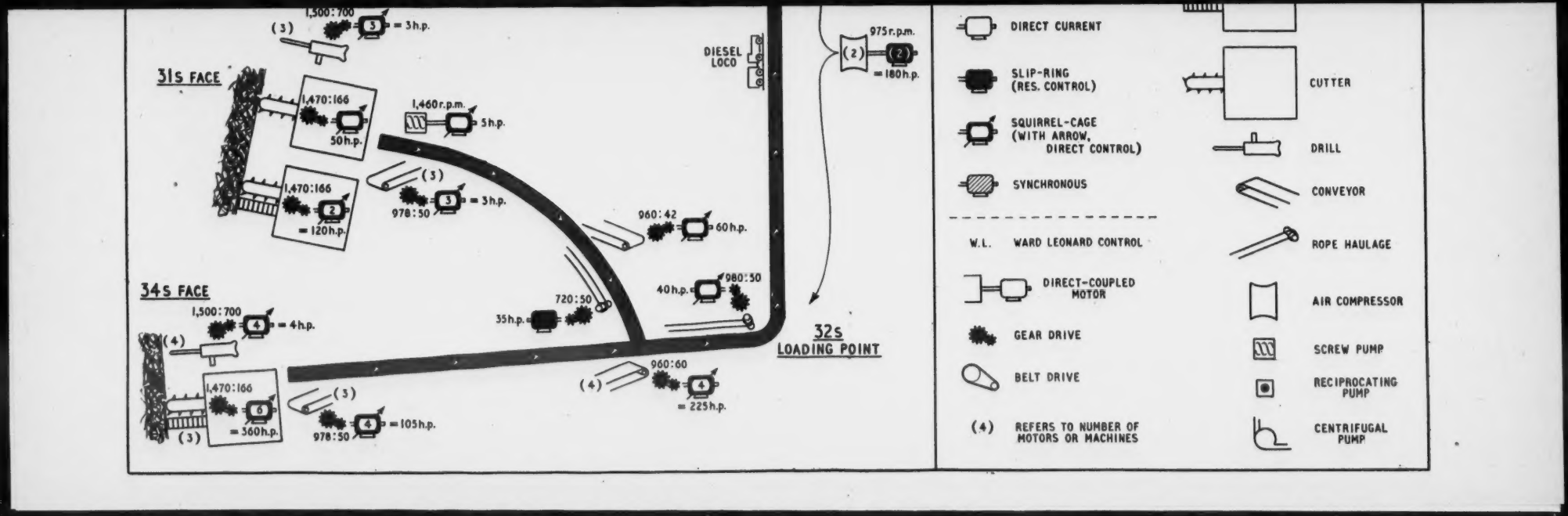
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VIEWS on the NEWS

By REFLECTOR

IT has always been the electrical contractors' fear or belief that the installation departments of electricity supply authorities (both before and since nationalization) were subsidized from the profit on the sale of electricity. They should therefore be happy at a recent statement by Mr. Walter Lewis, Chairman of the Midlands Electricity Board. Speaking at a Rotary Club gathering, he said (as reported by the *County Express*, Stourbridge) that the profit made by the Board on the sale of appliances went to the general funds to help keep down the tariffs. He was replying to a suggestion by a past-president of the Club that the Board should "stick to electricity and forget about selling appliances."

Upon this same question the Electrical Trades Union has suggested to the Herbert Committee that the Boards are not doing enough in the way of installation work and selling appliances. The Union thinks that there ought to be a six-year programme, as there is for generating plant. It is sadly evident that the electrical contractors and their employees hold totally opposed views on this subject.

* * *

The plight of many Retford residents when the local gasworks was put out of action recently is dealt with in an article by Margit Hayek in the *Manchester Guardian*. She says that nearly everybody she talked to seemed to cook with gas and housewives with electric cookers or slow combustion cookers seemed to be either elusive or rare. In her own household, however, breakfast was not too complicated for she has an electric kettle and toaster. Another enterprising housewife toasted her bread with an electric iron and "a clever electrician" in the district converted electric fires into cooking appliances. Electric cookers were brought in from a neighbouring town to the hospital so that the patients could have a cooked tea after having had a cold lunch. The author concludes her article:—

> "I had also expected that the Electricity Board would send all its available demonstration cookers to Retford and try to convert gas-cooker addicts into electric cooker fans. There was no such experiment so far as I could discover."

Perhaps the Board thought it was not playing the game to take advantage of its rivals' misfortune—and, after all, there are such occurrences as electricity breakdowns, even though they are of shorter duration and more easily remedied.

* * *

Let it not be thought that I am unsympathetic towards old-age pensioners but some suggestions for the alleviation of their difficulties strike me as rather ridiculous. Already they secure cheaper tobacco, whether they smoke or not; and several municipal authorities are promoting legislation to enable them to travel free of charge on local transport services. Proposals have previously been made that these people should be charged less for their electricity and now, according to the *Evening Standard*, the Hertfordshire Association of Women's Clubs "is demanding that the fixed charge for electricity should be waived in the case of elderly people." Whether any similar concession for gas was proposed is not stated but it is unlikely. It is always electricity that is picked on, whether it is for elderly people, farmers, or any other section of the community, when special terms are sought.

* * *

I have frequently remarked upon the propensity of large birds to foul overhead power lines. This is regarded in two lights: one is the humanitarian which regrets the effect upon the birds and the other is the utilitarian which considers power stoppages a nuisance. Both schools of thought will be pleased to know that the South Eastern Electricity Board has taken steps to prevent further breakdowns caused by swans flying into the lines. It is not stated in the *Folkestone Herald*, from which I gather the information, what the nature of these steps is. The Board's control over the birds themselves must be limited and so it looks as though something has been done to the lines, either by way of protection or separation which sounds rather costly.

* * *

Among a number of exaggerated claims for gas cooking in a current advertisement by the Gas Council it is stated:—

> "It's always easy to see exactly how much heat you are using, thanks to Mr. Therm's ever-visible flame."

More than that, you can actually smell how much heat you are using, thanks to Mr. Therm's all-pervading odour.

* * *

Sixty years ago thoughts were turning to the filling-in of load-curve valleys which were even deeper then than they are now. To the *Electrical Review* of 29th March, 1895, Mr. H. J. Dowsing (a well-known name) contributed an article on the subject in the course of which he said:—

> "The field for electric heating is undoubtedly a wide one and, if properly covered, would mean great things for the supply companies. It would do more than anything else to help fill up the "valleys" and level the load curve. . . . Wherever short periods of heating are required electricity has its chance. Thus, in theatres and public buildings four hours, probably three, represent the time each day that heat is required. . . . It is wasteful to light up a large heating system which may require hours to reach the necessary temperature in order to warm the building for so short a time. . . . The prejudice to be overcome, however, is very great. It is probably a question of time, for I believe that when the many advantages of electric heating are known, it will be considered as much a necessity in the best class of house as the electric light is at the present time."

PERSONAL AND SOCIAL

News of Men and Women of the Industry

A farewell presentation was made to the **Rt. Hon. Thomas Johnston,** part-time member of the British Electricity Authority, by his fellow members, past and present, and the chief executive and other officers of the Authority, at the last meeting of the Authority held recently under its original title. Mr. Johnston, who had been a member of the Authority since its formation, *ex officio* chairman of the North of Scotland Hydro-Electric Board, retired at the end of March by the operation of the Electricity Reorganization (Scotland) Act, 1954. The presentation consisted of a travelling flask, appropriately filled, and a silver salver on which was inscribed the signatures of those on whose behalf the presentation was made.

The Rt. Hon. Thomas Johnston receiving a presentation from Lord Citrine on his retirement from the British Electricity Authority

Lord Citrine, chairman of the Authority, making the presentation, recalled his long association with Mr. Johnston and spoke of his high personal regard for him. Mr. Johnston, he said, had always been a welcome and helpful colleague in the deliberations of the Authority. Although Mr. Johnston's retirement severed the official link between the Authority and the Hydro-Electric Board, the arrangements already made ensured that close consultation and collaboration would continue in the future as in the past. Expressing his thanks for the souvenirs of a very happy association, Mr. Johnston said that he hoped that the friendly collaboration of his Board and the Authority in the past seven years would not only continue but be strengthened in the future.

Mr. R. J. B. Tiernay, A.S.A.A., A.C.I.S., senior assistant accountant in the Midlands Division of the Central Electricity Authority, has been appointed accountant of the Division in succession to Mr. W. Roberts, who recently retired. Mr. Tiernay was with the West Midlands Joint Electricity Authority for twenty-one years before nationalization, first as senior accountancy assistant and, from 1943, assistant accountant.

Sir William J. Larke, K.B.E., who will be eighty on 26th April, is to be the guest of honour at a luncheon organized by the Institute of Welding and the British Welding Research Association at the Hyde Park Hotel on the previous day. The chair will be taken by Sir Claude Gibb, F.R.S., supported by Sir Charles Lillicrap, K.C.B., M.B.E., chairman of the Council of the British Welding Research Association, and Mr. R. G. Braithwaite, president of the Institute of Welding. Further particulars and tickets are obtainable from the secretary, Institute of Welding, 2, Buckingham Palace Gardens, London, S.W.1.

The Senate of Queen's University, Belfast, has appointed **Mr. T. P. Allen** to the Chair of Light Electrical Engineering and **Mr. P. L. Burns** to the Chair of Electrical Engineering.

Mr. R. G. Mukherji, M.Sc., M.I.E.E., Member A.I.E.E., executive engineer, Northern Electrical Division, Government of West Bengal, informs us that he has been appointed electrical engineer with the National Delegation of India to the International Commission for Supervision and Control in Indo-China at Hanoi. His address is c/o International Commission for Viet Nam, Hanoi, Indo-China.

Mr. W. V. Binstead has joined the Development Department of the British Welding Research Association. In his capacity as a development engineer, Mr. Binstead will be visiting industrial organizations where assistance is called for in connection with welding problems. The Association is expanding its development service and, during the next two years, will be holding a series of lectures on "Increased Productivity due to Welding" in many parts of the country. This programme which Mr. Binstead is organizing has been made possible as a result of American funds that have been provided by the Department of Scientific and Industrial Research. **Mr. A. G. Thompson,** a member of the Association's staff, will attend the intra-European mission for the comparative study of welding techniques as a specialist in welding productivity nominated by the European Productivity Agency.

On 22nd March, at Marconi House, **Mr. J. E. Calverley,** M.I.E.E., received gifts from his colleagues to mark his retirement from the English Electric Co., Ltd. The presentations were made by Sir George H. Nelson, chairman and managing director.

Mr. Calverley, who has had a distinguished engineering career, was educated at Bentham Grammar School and Bradford Technical College. He joined the Phœnix Dynamo Co., Bradford, in 1908 as assistant designer, and in 1910 he went to Dick Kerr & Co., Preston, as assistant design engineer. From 1935 to 1941 he was chief engineer and manager of the English Electric Traction Department. In 1941 he went to Washington, where he represented the Ministry of Supply as d.c. adviser on electrical equipment for tanks and vehicles. He returned to Great Britain and to the English Electric Co. in 1943 as deputy chief engineer (technical). For the past three years he has been engaged on special consultancy duties for the company.

During his career Mr. Calverley was mainly concerned with d.c. design and application. He played a big part in the development of high voltage d.c. machines for the B.B.C. regional stations and had a great deal to do with mercury arc rectifiers. His work included the development of the Transverter, in association with the late Mr. W. E. Highfield. Mr. Calverley's interests have extended far beyond the confines of his normal duties. He has participated in the work of many organizations, including

Mr. J. E. Calverley thanking Sir George H. Nelson (centre) and his colleagues for his farewell presentation. On the left is Mr. H. M. Mathews, director of engineering

the Institution of Electrical Engineers, the British Electrical and Allied Industries Research Association, the British Electrical and Allied Manufacturers' Association, the British Standards Institution and the Conférence Internationale des Grandes Réseaux Electriques.

Mr. W. B. G. Collis

Mr. W. B. G. Collis, M.B.E., T.D., B.Sc., A.C.G.I., A.M.I.E.E., A.I.Loco.E., has been appointed manager of the Traction Department of the British Thomson-Houston Co., Ltd., in succession to the late Mr. E. T. Hippisley. Mr. Collis was educated at Shrewsbury and at the City and Guilds (Engineering) College, spending his long vacation in 1927 as a student with the B.T.H. Co. After taking his degree he went to the Metropolitan-Vickers Electrical Co. as a college apprentice in 1928. In 1931 he joined that company's Traction Control Department and six years later transferred to traction sales. During the war Mr. Collis served with the Royal Corps of Signals, being awarded the M.B.E. (Military Division) in 1940. Later he was appointed to the General Staff of the War Office. On demobilization he returned to Metropolitan-Vickers. After holding appointments in London and Manchester he was appointed (in 1953) assistant sales manager in charge of the M-V traction staff in London.

Mr. E. Yeeles

Mr. E. Yeeles, M.I.E.E., M.I.Mech.E., has been appointed works director of Laurence, Scott & Electromotors, Ltd., at the main works in Norwich. He commenced his training at C. A. Parsons & Co., Ltd., in 1922, and was subsequently in the Electrical Design Department. After a period with the Brush Electrical Engineering Co., Ltd., he went to Richardsons, Westgarth & Co., Ltd., as manager of the Electrical Department. In 1948 he joined the General Electric Co., Ltd., as works manager, Engineering Works, Witton, Birmingham, and remained there until January this year when he took up his appointment with Laurence, Scott & Electromotors, Ltd.

Mr. Alan Dewhurst, B.Sc.(Hons.), has been appointed a director of Dewhurst & Partner, Ltd., Hounslow. Mr. Dewhurst was educated at Woodhouse Grove School, near Bradford, and served in the Merchant Navy on radio and radar work during the war. He obtained his B.Sc. at University College, London, in 1949, and after completing his graduate apprenticeship with the British Thomson-Houston Co., Ltd., Rugby, joined Dewhurst & Partner, Ltd., in 1951. Since that time he has supervised the company's test section and is now engaged on designs for new equipment.

Mr. W. F. Pearce, M.I.Mech.E., M.I.H.V.E., chief engineer and general manager of the National Boiler & General Insurance Co., Ltd., who has attained the age of sixty-five, is retiring on 30th April. The directors have appointed **Mr. W. D. C. Goldie,** A.M.I.Mech.E., at present assistant chief engineer, to succeed Mr. Pearce.

The Plessey Co., Ltd., has appointed **Mr. T. P. Collier,** of Chicago, to be its sole representative in the United States. Mr. Collier, who is an engineer and member of many professional and business societies, has had considerable experience in international trade.

Mr. D. Winton Thorpe, T.D., M.I.E.E., Assoc.I.Mech.E., Membre de la Société Belge des Electriciens, has been appointed to the staff of Mather & Crowther, Ltd., incorporated practitioners in advertising.

Mr. L. A. Woodhead, general manager of Cossor Instruments, Ltd., is visiting New York to attend the I.R.E. Exhibition and will tour other North American cities to investigate electronic instrument requirements and promote the sale of British equipment.

The Council of the City and Guilds of London Institute announces that the **Hon. Maurice Lubbock** has accepted its invitation to become the hon. treasurer, an office which has remained vacant since the resignation in 1952 of Sir George Aylwen. **Sir George Nelson** has been appointed a governor of the Imperial College of Science and Technology in the place of the late Sir Henry Steward. Sir George, who is chairman and managing director of the English Electric group of companies, is a representative member of the Institute appointed by the Goldsmiths' Company and was elected a councillor in 1945. **Major-General C. Lloyd** has been appointed director of the Institute in addition to his post as director of the Department of Technology.

Mr. G. W. Parkin, A.M.I.E.E., who has been appointed electrical assistant to the chief mechanical and electrical engineer, British Railways (London Midland Region), Derby, entered the service of the Mersey Railway as a junior engineer at Birkenhead Central in 1922. He was appointed engineering superintendent of the Mersey Railway in 1928 and in 1953 went to Derby as assistant (electric traction and generation) to the mechanical and electrical engineer.

Mr. J. Mould (right), deputy chairman, East Midlands Electricity Board, presenting the chain of office to the president, Mr. G. Grove, at the eighth annual dinner-dance of the Leicester Electrical Society on 18th March

Mr. R. W. Douglas, B.Sc.(London), F.Inst.P., F.S.G.T., a member of the senior research staff of the Research Laboratories of the General Electric Co., Ltd., Wembley, will shortly be leaving on his appointment to the Chair of Glass Technology at the University of Sheffield. Mr. Douglas joined the G.E.C. Research Laboratories in 1927 and has published many papers on the physics of glass. Of recent years his work at the laboratories has also involved responsibility for fundamental investigations into the nature of semiconductors. Since 1949 he has been hon. secretary of the Society of Glass Technology.

Mr. J. P. Clifton, A.C.G.I., A.M.I.E.E., has been appointed manager of the Contract Department at the Witton Works of the General Electric Co., Ltd., in succession to the late Mr. W. E. Evans. Mr. Clifton was educated at Imperial College, City and Guilds (Engineering) College, and

Mr. R. W. Douglas

Mr. J. P. Clifton

joined the Metropolitan-Vickers Electrical Co., Ltd., as a graduate apprentice in 1913. His training was interrupted by the war, during which he held a commission in the Royal Artillery and served in the Italian Expeditionary Force. He returned to the Metropolitan-Vickers Electrical Co. in 1919, and after completing his apprenticeship was appointed to the staff of various sales departments and was later transferred to the Contract

Department. He joined the General Electric Co., Ltd., in 1935 as deputy manager of the department which he now controls.

At the annual general meeting of the Electrical Wholesalers' Federation on 17th March **Mr. R. E. Silvey,** Santon (Wholesale), Ltd., was elected president of the Federation for the ensuing year. Mr. Silvey joined the Council in 1951 on the retirement of Mr. A. C. Baker, and has served as councillor of the South Western and South Wales Section. **Mr. T. D. Woods,** Downes & Davies, Ltd., has been elected vice-president. Mr. Woods is the son of

Mr. R. E. Silvey

Mr. C. H. Blackburn

Mr. G. Conradi

Mr. Tom Woods, who was president of the Federation in 1940. **Mr. C. H. Blackburn,** E. Dawson (Lamp Factors), Ltd., London, was elected councillor of the London and Eastern Section in succession to **Mr. E. J. Beaver,** who is retiring from the Council; **Mr. G. Conradi,** British Central Electrical Co., Ltd., London, was elected a general councillor in succession to **Mr. E. A. V. Peckham,** past president, who has retired; and **Mr. C. H. Marr,** the E.G.S. Co., Ltd., and **Mr. H. Riley,** John Riley & Son (Electrical), Ltd., Sheffield, have been re-elected as North East Coast and Yorkshire and Mid-East Section councillors respectively.

At a meeting of the new council following the annual general meeting in London on 24th March, **Mr. C. M. Benham,** B.Sc., A.C.G.I., A.M.I.E.E. (managing director, Painton & Co., Ltd.), was elected chairman of the Radio and Electronic Component Manufacturers' Federation in succession to **Mr. W. F. Randall. Mr. S. H. Brewell,** M.B.E., M.I.P.E. (chairman and managing director, A. H. Hunt Capacitors, Ltd.), was elected vice-chairman. **Mr. H. V. Slade,** M.B.E., remains hon. treasurer.

Miss M. G. Reading, in charge of the E.A.W. Inquiry Bureau since 1946, retired on 31st March. Previously in the electrical industry for over thirty years, she represented the saleswomen on the E.A.W. Training and Diploma Committee, and was a member of the National Advisory Council. She was the first chairman of the London Demonstrators' Circle.

The annual Long Service Association dinner of **Everett, Edgcumbe & Co., Ltd.,** Colindale Works, was held on 25th March at the "Surrey Arms," Hendon, when gold watches were presented to twelve employees with thirty years or more service. Speeches were made by the chairman of the Association, Group Capt. F. C. Beresford-Peirse, and the managing director, Mr. R. E. Everett, who proposed the toast of the Association before making the presentations. Mr. H. B. Carpenter replied on behalf of the recipients and proposed a toast to the prosperity of the company.

Last week the **Institution of Engineers-in-Charge** held its fiftieth annual dinner at the Holborn Restaurant, London, marking sixty years since its actual inception.

Lord Sempill proposed the toast of the Institution and after mentioning the importance of engineers keeping abreast of ments he stressed, new developas do so many nowadays, how we in this country had great inventive genius but were slow in developing its products.

The president of the Institution, Mr. R. L. Quertier, responding, referred to the cameraderie that existed among engineers at all levels and said that they were most anxious to encourage young engineers to join their Institution.

Sir William Larke proposed the toast of the guests for whom Mr. W. A. Macfarlane, director of the National Fuel Efficiency Service, replied. Musical entertainment was provided and later the health of the president was proposed by Mr. F. E. Shaw, chairman of the Institution.

The North West (Manchester) Area meeting of the **Electrical Industries National Golf Championship** will be held this year at Torkington (Stockport) Golf Club on 4th May. Golfing members in the electrical industry who wish to compete can obtain particulars from Mr. J. K. Dean, hon. secretary, c/o Metropolitan-Vickers Electrical Co., Ltd., Ship Canal House, King Street, Manchester, 2.

The latest production of the **G.E.C. Dramatic Society,** put on at the Fortune Theatre, London, W.C.2, for three nights last week, showed that this company of players is maintaining its high standard. The play was a comedy by Kenneth Horne, "A Lady Mislaid," with a well worked out plot and bright dialogue which gave full scope to the talents of Florence Scantlebury ("Mrs. Small"—a loquacious domestic), Paula Kirkby ("Jennifer"—a temperamental waitress), Doreen Webb ("Esther, Jennifer's more sober sister), Ian Stewart ("Bullock," a rather delicately-constructed detective), Terence Hill ("Mr. Smith," a visitor around whose activities the action revolves), Michael Hobbins ("George," Jennifer's somewhat obtuse fiancé) and Phyllis Gould (probably Mr. Smith's wife). Iris Ballard was the producer.

OBITUARY

Mr. Victor J. Hill died suddenly in Birmingham on 21st March. He was educated at Framlingham College, and then served an apprenticeship with Crompton & Co. After training he joined the Wakefield & District Light Railway Co. as engineer and some years later went to the Birmingham Electric Supply Department under Mr. F. Forrest. From there he joined Crompton & Co. in Birmingham as sales engineer, and in 1929 joined the Donovan Electrical Co., Ltd., where he remained until his death. The funeral service and cremation took place at Lodge Hill cemetery on 25th March.

WILLS

Mr. W. Mills, director of Brook Motors, Ltd., who died on 25th December, left £136,073 gross (£128,444 net).

Mr. A. H. Ginman, company director, formerly president of the Canadian Marconi Co., who died on 7th November last, left estate in England valued at £14,624 gross (£12,793 net).

Mr. F. Isherwood, late a director of Yorkshire Switchgear and Engineering Co., Ltd., who died on 15th October last, left £14,503 gross (£14,308 net).

Mr. F. Smith, chief electrical engineer at Pinxton Collieries, who died on 13th November last, intestate, left £6,252 gross (£6,191 net).

Mr. T. R. Hills, founder of Thomas R. Hills, electrical wholesalers, Ashford, who died on 23rd November last, left £10,458 gross (£9,379 net.)

Mr. C. W. Emanuel, D.F.H., M.I.E.E., of 47a, Woodcote Road, Wallington, Surrey, district manager at Sutton to the South Eastern Electricity Board, who died on 16th October last, left £5,545 gross (£5,468 net).

PRICES OF MATERIALS

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

ALUMINIUM Ingots	ton £163 0s 0d
COPPER, H.C. Electro	ton £360 0s 0d
Fire Refined 99·70%	ton £358 0s 0d
Fire Refined 99·50%	ton £357 0s 0d
COPPER Tubes ..	lb 3s 4½d
Sheet	ton £422 5s 0d
H.C. wire and strip ..	ton £398 10s 0d
LEAD, English	ton £104 5s 0d
Foreign	ton £103 0s 0d
MERCURY	flask £109 10s 0d
TIN, block (English) ..	ton £719 0s 0d
ZINC, G.O.B. Foreign	ton £88 5s 0d
Electrolytic	ton £96 0s 0d
BRASS Tubes (solid drawn)	lb 2s 8½d
Sheet	ton £332 15s 0d
Wire	lb 3s 3½d
PHOSPHOR BRONZE Wire	lb 4s 11½d
PLATINUM	oz £29 0s 0d
RUBBER, No. 1 R.S.S. spot	lb 27½d—27⅞d

INDUSTRY AND THE HOUSE

By A. M. F. PALMER, A.M.I.E.E., M.P.

ALTHOUGH there has been no full-scale debate directly involving industrial and engineering matters since my last contribution to these columns, there has been fairly lively questioning of Ministers. For instance, the Minister of Fuel and Power, Mr. Geoffrey Lloyd, was severely heckled last week on the coal stock position and he needed all the resources of his considerable skill as a front bench performer to parry the thrusts made at him from the Opposition side. The occasion seemed to show that at long last Labour Members are recovering from the mental inhibitions caused by the nationalization of the fuel and power services. There has been undoubtedly a feeling in the past that to attack the Ministry of Fuel and Power was to attack nationalization; this was a pity since the healthy functioning of parliamentary life depends on assuming that every government is a little less than competent and that it could be replaced with advantage by every Opposition.

The Coal Supply Position

Several Members, with an eye on their constituents' needs, asked for information on the scarcity or otherwise of coal supplies. Mr. Thomson wanted to know all about the position in Dundee; Mr. Moyle alleged hardship in Oldbury and Halesowen; Mr. Wells thought his constituents in Walsall were having a cold deal and Mr. Langford Holt, a Conservative, was even anxious for the Minister to delve into history and to make a " full statement of the past and present coal supply position in Shrewsbury."

To the slight astonishment of the House the Minister stated that generally coal stocks were still well above the average for the time of year; in particular industrial stocks were sufficient. Although special action had been required at one or two gasworks, electrical power station supplies were perfectly safe. (Mr. Lloyd added with pride that there had been no power cuts; he was allowed to take credit for this by a House not suspecting the normal and different relationship between power cuts and plant availability.) He went on to report that British coal output increased last year until the winter, when it started to decline. In the first ten weeks of 1955 coal output was 1·1 million tons less than in the corresponding period of 1954 and 3·5 million tons less than current inland consumption. It was fortunate that last summer arrangements had been made for large imports to come in throughout the winter months. The House would appreciate that foreign coal had played an essential part in maintaining reasonable fuel availability during a difficult winter.

Indefatigable Mr. Nabarro wasted little time in joining from the Conservative benches the hunt after the Minister. The pessimistic Member for Kidderminster predicted that during the next twelve months the country would have to import as much as ten million tons of coal. He advised in those circumstances that it would be " propitious " for the Minister to renew efforts to impress upon the whole of British industry the urgent need for using coal with much greater efficiency. Unfortunately, apart from agreeing with the wisdom of Mr. Nabarro's gratuitous advice, Mr. Lloyd did not indicate whether he thought any extra action to stimulate industrial coal conservation was possible.

After Mr. Dodds and Mr. Gibson had pressed the Minister further on the domestic position, Mr. Gaitskell, as befits both a former Chancellor of the Exchequer and a former Minister of Fuel and Power, raised an important point of principle. In view of the large scale on which imports of coal had been taking place, was it wise to continue to export so much coal? Heavy exports meant importing coal, certainly of different qualities but nevertheless at a high price. Mr. Lloyd replied a little tartly that he thought Mr. Gaitskell should be aware of the desirability of keeping " a foot " in traditional markets if we were to protect the future. The result was that questioning ended on a note of recrimination with Mr. Gaitskell saying that under the Labour Government it was not necessary to bring in coal from overseas on the present scale, and with Conservative back benchers raising shouts of " What about 1947?" being a reference, of course, to the fuel crisis in the February of that early post-war year.

A debate of general interest but not without its industrial aspects was on a motion brought by Dr. Edith Summerskill and other Labour women Members concerning what she called " the strange and difficult " subject of the effects on humanity of continuing nuclear explosions. She asked that a conference of scientists from America, Russia, France and Britain be held to advise on the possible dangers facing mankind. Quoting Lord Adrian, she alleged that uncontrolled experimentation with nuclear energy might lead to a degree of radioactivity which in the end human beings would be unable to tolerate since the effect of radiation in the atmosphere was cumulative. Although uranium and radium were found all over the earth, any addition to the existing stores of radiation might be responsible for increases in the incidence of some disease.

Medical Effects of Radioactivity

Moving a Government amendment to the effect that the House welcomed the Government's decision to continue and expand research on the medical and biological aspects of nuclear energy, the Minister of Health said that the pronouncement on the effect of test explosions that had caused a good deal of comment and some controversy was that of the United States Atomic Energy Commission. British calculations, derived from monitoring measurements taken by the Atomic Energy Authority, showed that in this country the figure would be about one-third of the American figure (of about one-tenth of one rontgen unit). This included all the future radiation results of all the explosions that had taken place so far. Even the figure of 0·03 was artificially high; it was calculated on the assumption that a man had been outside in the open for " twenty-four hours a day for about fifty years." The extent that he was indoors or under cover would greatly reduce the figure. It also assumed that none of the activity weathered away from the surface of the ground. Was there a threshold of radioactivity, which even if not there now we might reach in the future, beyond which man's genetic constitution might stand at risk? The dose of radiation which had been agreed by an international commission for workers and radiologists subject to it as permissible was 0·3 of an R unit a week, or perhaps 15 a year.

Mr. Macleod was against an international scientific conference because he felt that such a conference would be unable to escape from the political issues inevitably

bound up with the subject. Indeed, a Geneva conference of scientists might well detract from the all-important question of the peaceful uses of the new power source. There had never before been a fount of energy in the world which offered such possibilities of doom and yet such bright possibilities of hope. For good or evil this energy was now with us, he said, and in spite of dread warnings, mankind could use it properly and replenish the earth.

Some excellent speeches were made by several lady Members in the debate, but they were of necessity concerned mainly with the political and medical aspects of the question; however, the figures and authoritative statements which emerged should be of value—and maybe some consolation—to engineers, technologists and others who will be called on to work in close proximity with potential radioactivity.

Nuclear Reactor for Private Research

THE first American nuclear reactor designed for private industrial research is to be built for the Armour Research Foundation of Chicago by North American Aviation Inc. The site will be in the grounds of the Illinois Institute of Technology and construction will begin as soon as design and safety arrangements have been approved by the Atomic Energy Commission. It is hoped to complete the building of the reactor by the end of this year.

The new reactor is expected to cost about $500,000 and will have a power output of 50 kW. It will be housed in a room 48ft long, 72ft wide and 30ft high, and atomic fission will take place in a steel sphere about 1ft in diameter, surrounded by thick stacks of graphite bars as reflectors, and 5ft thick concrete blocks. The complete reactor will be about 18ft long by 16ft wide and 11ft high. The steel sphere cone will contain about four gallons of uranyl sulphate, enriched with Uranium 235, in a water solution and the reactor is therefore called the " solution " type.

The rate of fission will be controlled by four boron rods which absorb neutrons when near the cone but permit fission to take place when withdrawn. Fissionable material to charge the reactor will be obtained from the Atomic Energy Commission on an " extended loan " basis as permitted by recent American legislation. No secrecy of any kind other than that required in the course of trade developments is applicable to the operations of the reactor. The machine is not for use on research on reactors or for electrical power generation, but is another " tool " in the equipment of the Research Foundation, designed to carry out particular research to a sponsor's requirements. It will investigate the use of radioactive isotopes, the sterilization of food and drugs, the structure of plastics, rubber and similar materials, wear and friction, etc.

Neutron activation is one operation which can be performed, making possible a highly sensitive method of elemental chemical analysis. Detection of many elements with a sensitivity as great as 10^{-12} grams is possible. Neutron diffraction is used as a method of structure analysis and has already proved valuable in the study of organic compounds, oxygen and hydrogen in solids, etc.

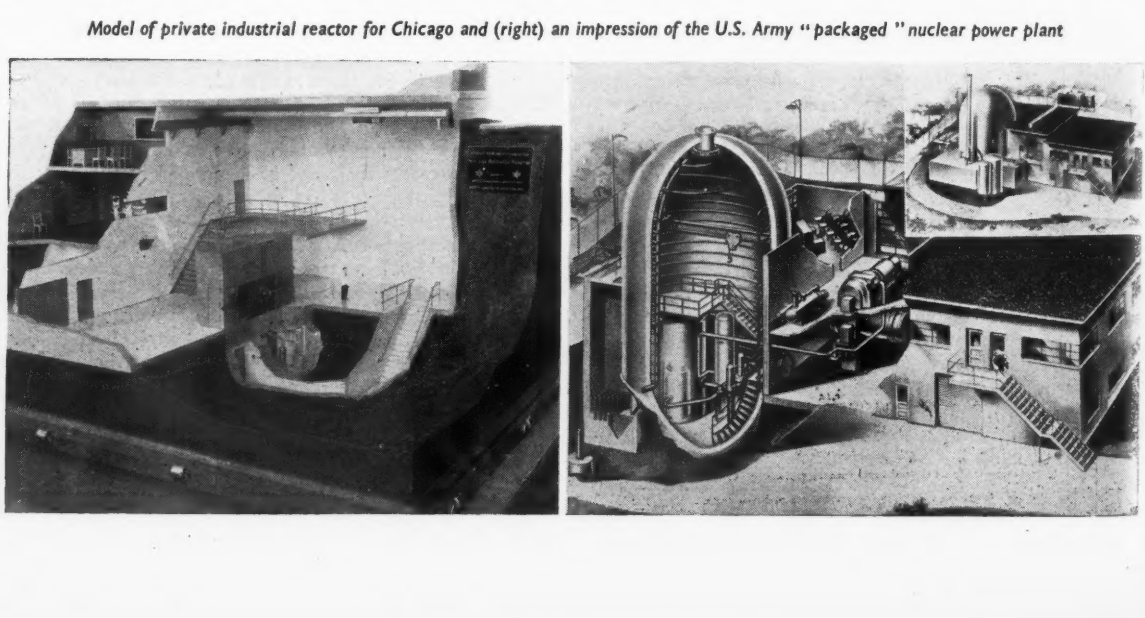
Another reactor planned for construction in the United States is a prototype " package " type for use by the army. This will be built so that its components can be transferred by air to remote bases anywhere in the world. This type of reactor, used to generate power, has the obvious advantage of not requiring a flow of fuel once erected. The prototype is to be built at Fort Belvoir, Virginia, and is expected to be in operation in about three years.

Coal Fired Gas Turbine

AT a meeting in Birmingham on 25th March Mr. Geoffrey Lloyd, Minister of Fuel and Power, announced that a new method had been developed in Great Britain of harnessing the principle of the jet engine to the combined production of heat and electric power; and this gas turbine worked not on oil, but on pulverized coal. For the first time in any country electricity generated by a coal burning gas turbine had been used for public supply.

The experimental tests which began last week, took place at Clydebank, near Glasgow, the project being a joint venture between John Brown & Co. (Clydebank), Ltd., and the Ministry of Fuel and Power, employing an experimental 700 kW closed cycle gas turbine burning pulverized coal and used for the double purpose of generating electricity and supplying hot water for part of the works heating system. At present this method was experimental, said the Minister, and one of the main objects of the present trials was to assess its commercial possibilities.

Model of private industrial reactor for Chicago and (right) an impression of the U.S. Army "packaged" nuclear power plant



PARLIAMENTARY REPORT

IN the House of Commons debate on the Opposition motion relating to the dangers facing humanity as the result of continuing radioactive contamination of the earth's atmosphere, Mr. Nigel Birch, Minister of Works, said that there was no danger of radioactivity from the use of atomic power for civil purposes. The danger would not be increased when we had atomic power stations. Such radioactive materials as were emitted were very weak and their effect was not cumulative. Their radioactivity ceased almost at once. He wanted to dispose of any suggestion that the use of atomic energy for civil purposes raised any danger.

Nuclear and Water Power

None of the sites for the projected nuclear power stations has yet been chosen, the House of Commons was informed last week by Mr. Henderson Stewart, Under Secretary of State for Scotland, when Mr. Gerald Nabarro asked the Government to consider whether it was desirable, in view of the advent of such stations, to build any more hydro-electric stations.

Mr. Nabarro had asked the Secretary of State for Scotland what steps he was taking to revise the new water-power capital construction plans, 1955-65, of the North of Scotland Hydro-Electric Board, in view of the onset of nuclear power generation.

Mr. Henderson Stewart replied that the Secretary of State did not consider that the nuclear power programme required any revision of the Board's plans so far submitted to him. The Board had told him, however, that they were considering the development of large-scale pumped storage schemes which might prove to be of increasing importance as the development of nuclear power proceeded.

Mr. Nabarro asked if the Secretary of State would bear in mind that the conventional hydro-electric schemes which had been built in the Highlands had an anticipated life of 100 years. In view of the fact that nuclear power stations would probably be in operation within ten years, was it not desirable to reconsider any plans for building further conventional hydro-electric stations?

Mr. Stewart replied: "These considerations are very much in our minds, but I can assure Mr. Nabarro for reasons which I could well give him that what we are doing now is very sound."

Sir David Robertson asked whether a single site had been found to be suitable in the United Kingdom for the nuclear power stations.

Mr. Stewart said he was not aware that the authorities had yet decided upon one.

Mr. Rankin asked if the Secretary of State had consulted the North of Scotland Hydro-Electric Board about the part it might play in nuclear power development.

Mr. Stewart said this matter was well in hand.

Mr. Nabarro asked how many of the twelve projected atomic power stations were to be in Scotland and how far it was proposed that the North of Scotland Hydro-Electric Board should participate.

Mr. Stewart replied that no decision had yet been reached on the location of any of these stations, but the Scottish Electricity Boards and the British Electricity Authority were in consultation with the Atomic Energy Authority on this and other matters.

Fuel Research

In answer to Mr. Frederick Willey, the Parliamentary Secretary to the Ministry of Works (Mr. Bevins) said that a site for a new Fuel Research Station had been selected at Stevenage. Specifications for the requirements for the first buildings on the new site had been drawn up and had been submitted to the Ministry of Works for the preparation of sketch plans and estimates.

Corrosion Problems

Mr. Bevins told Mr. Dodds that much progress had been made towards a full understanding of the causes of corrosion and in devising methods of prevention. These methods were being applied both by Government Departments and by industry.

Railway Plans

In the second reading debate on the Transport (Borrowing Powers) Bill in the House of Lords, Lord Hawke, Lord-in-Waiting, gave an indication of the phasing of expenditure under the railway modernization plan. There would be three main types of expenditure: first, normal replacement; second, replacement of assets by something more modern, such as diesels and signalling and track improvements; and third, provision of entirely new work, such as new goods yards and big electrification schemes.

In the years 1955 to 1959 the British Transport Commission expected to spend £350 million on the railways and £100 million on the London Passenger Transport Board and their other activities; of this £200 million would be drawn from internal reserves. Of the railway share, £250 million would go on rolling stock and £100 million on civil engineering and the like. At the end of that period there would remain £75 million of borrowing powers available for further projects of the modernization plan.

Lord Hurcomb wished the Commission every success but he suspected it would not be long before further borrowing powers would have to be authorized. Meanwhile, this was a substantial, but by no means excessive, allocation of the nation's capital resources to a vital public need.

Telephone Development

In the House of Lords the Postmaster-General, Earl de la Warr, made a statement on the progress which had been made in connecting new telephones. He said that in 1951 there were nearly half a million people waiting for telephones and new connections were being made at the rate of 355,000 per annum. By 1954 this rate had been stepped up to 410,000. Meanwhile, there had been a great increase in the demand for telephones, the number of new applications received in 1953 and 1954 being 15 and 30 per cent greater than in 1952. Despite this the Post Office managed to reduce the waiting list to 360,000 by 31st December, 1954, but demand continued to increase and in January was the highest ever recorded. Capital investment was £50 million in 1951-52 and £70 million in 1954-55. The Post Office estimate for 1955-56 included the provision of £81 million which should enable them to supply at least 455,000 new connections in the coming year. This was nearly double the pre-war record of 240,000.

Washing Machine Hire Purchase

When the recently imposed hire-purchase restrictions were discussed in the House of Commons, Mr. Ivor Owen Thomas said he found difficulty in understanding the fourth order in the new regulations which applied to "washing machines and washers which are designed for heating water by electricity and gas, but which are not otherwise designed for operation by electricity or gas, including wash boilers and coppers." His interpretation of this was that if the washing machine was operated by power and not by hand the purchaser was not allowed to pay for it by a period purchase agreement. He could not understand why there should be this distinction. It would have rendered a service to the community if the Government had left things as they were.

Mr. Henry Strauss, Parliamentary Secretary, Board of Trade, who replied to the short debate on the subject of the restrictions, did not refer to this point. He estimated the amount of credit outstanding under hire-purchase agreements at the end of 1954 at between £350 million and £450 million —a probable increase during the year of £100 million. These figures came mainly from Hire Purchase Information, Ltd., the Radio and Television Retailers' Association, annual figures

published by the Gas Council and the British Electricity Authority, and the balance sheets of companies. The aim of the new regulations was to reduce internal demand roughly over the whole field of durable consumer goods. It would not cause hardship but it would oblige people to find the money rather more quickly than in the past.

Australian Import Restrictions

In reply to Mr. Harold Wilson, the President of the Board of Trade (Mr. Peter Thorneycroft) said that the Australian Government had felt obliged to impose new import restrictions in order to arrest the fall in the reserves. It seems likely that, in the next financial year, a saving of up to £80 million might be achieved on the current rate of imports. The effect on the United Kingdom might therefore be of the order of £30-£40 million out of exports amounting in 1954 to £278 million. It was not possible to forecast the effect on particular industries since quotas were available for imports from any non-dollar source and in some cases for a variety of alternative goods. Mr. Thorneycroft said he did not consider that any formal representation against the general policy of the Australian Government in seeking to safeguard the balance of payments position would be either effective or appropriate. He would, however, be in touch with the Australian authorities on detailed matters arising from these measures. The Australian Government had made it clear that it intended to relax these import restrictions as soon as the balance of payments position permitted.

Coal Supplies

In the House of Commons this week Mr. Geoffrey Lloyd, Minister of Fuel and Power, replying to Mr. Gerald Nabarro, said that it was estimated that coal consumption in this country might increase another 4 or 5 million tons in the coal year beginning on 1st April. He added that the Government was taking action in all the various ways mentioned by Mr. Nabarro to bridge the likely gap between requirements and home supplies.

Mr. Palmer asked the Minister of Fuel and Power if, in view of the increasing coal shortage and the urgent need for a positive inducement to conserve industrial coal supplies, he would now reconsider his previous decision against a levy on private industry for the funds of the Fuel Efficiency Company.

Mr. Lloyd replied: "No, sir."

Mr. Palmer asked if there could be any hope of industry doing anything about fuel conservation unless the Minister imposed some sort of penalty or offered some more positive inducement? Tremendous savings could be made in industry.

Mr. Lloyd said he thought the National Industrial Fuel Efficiency Service was making good progress. Members would have noticed recently its more aggressive advertising campaign in all sorts of technical journals.

Mr. Palmer also asked the Minister if he would state the steps he was taking to encourage the use of oil as a substitute for coal in industry and elsewhere and the approximate estimated saving in annual tons at the end of the next five-year period.

Mr. Lloyd said he was discussing with Government Departments, nationalized industries and other public authorities how they could save coal by using more oil. Government loans were available to industrialists who could make worth-while savings by changing from coal to oil, and he was glad to say that the use of oil was increasing rapidly.

Road Lighting

Mr. R. G. Page asked the Minister of Transport what steps he was taking to promote improved road lighting, having regard to the fact that despite the reduced traffic during a great part of the hours of darkness, nearly one-third of the casualties to adult road users occurred during those hours.

Mr. John Boyd-Carpenter replied that contributions were made to lighting authorities of half the cost of installing and maintaining approved lighting systems on trunk roads. Increasing funds were being made available for this purpose. He was not empowered to provide financial assistance for street lighting on other roads, but it was evident from the volume of loan applications sponsored by his Department that local lighting authorities, whose responsibility this was, were providing new or improved lighting on a substantial scale.

Proposed New Tube Railway

Mr. Boyd-Carpenter told Mr. Albu that, as a necessary step in the detailed planning of the proposed Route C tube, powers to construct were contained in the British Transport Commission's Bill now before Parliament. No decision could be taken with respect to construction until this preliminary work had been done. This seemed to him wholly consistent with the report of the recent Committee of Inquiry into London Transport.

Monopolies Report

In reply to Mr. Dodds, Mr. Thorneycroft said he expected to receive by the middle of the year a report from the Monopolies Commission on a reference under Section 15 of the Act of certain widely prevalent discriminatory practices.

Austrian Railway Electrification

We learn from Mr. R. E. Kaan, author of the article "Austrian Railway Electrification" (*Electrical Review*, 25th February, p. 305), that the most westerly point on the map marked Bludenz should read Buchs. Bludenz is, in fact, situated between Feldkirch and Arlberg Tunnel.

Safety and Factory Efficiency

The third Safety and Factory Efficiency Exhibition, organized by the Birmingham and District Industrial Safety Group, will open on 24th June and will continue for one week. The emphasis of the exhibition is on the safety, health and welfare of all industrial workers, coupled with factory efficiency in the broadest sense. All types of mechanical guards and other devices designed to protect operators in the use of modern machinery will be on view. During the week-end (24th to 26th June) a residential congress will be held, and will comprise contributions by speakers under the general title of a "Social and Factual Examination of Industrial Accidents." Opportunity is being taken to arrange a series of day and half-day conferences during the week and the Institute of Industrial Supervisors, Institution of Works Managers, Institute of Personnel Management and the British Electricity Authority have agreed to take part.

Electrical Industries Club

The annual general meeting of the Electrical Industries Club will be held on 12th April at the Connaught Rooms, London, W.C.2 (2.30 p.m.). Mr. Leslie Gamage has been nominated as the first president of the Club and will be formally elected at the meeting. The guest speaker at the luncheon which precedes the annual meeting will be Chief Officer R. W. Moreton of the British North Greenland Expedition. Members are asked to note that in order to avoid clashing with another important luncheon, the May luncheon of the Club will be on 17th May and *not* 10th May.

The report of the General Committee for 1954 deals with the formation of the club and lists the guest speakers at the monthly luncheons during the year. Of the members of the present General Committee four are retiring: Sir John Dalton, Sir Henry Self, Mr. A. B. Wildsmith and Mr. W. E. Babb. The last two have offered their names for re-election as ordinary members of the Committee. There have been sixteen nominations for the four vacancies.

Institute of Metal Finishing

The spring conference of the Institute of Metal Finishing will be held at the Palace Hotel, Torquay, from 17th to 21st May. Papers on chromium plating, alloy deposition, organic finishing and education for the metal finishing industry are included in the programme. Further particulars can be obtained from the conference secretary, Institute of Metal Finishing, 32, Great Ormond Street, London, W.C.1.

Housecraft Advisers' Conference

THE annual conference of electrical housecraft advisers and senior demonstrators opened on Tuesday last week in the Assembly Hall of the Royal Empire Society, London. The conference was organized by the British Electrical Development Association and the Electrical Association for Women, and 320 electrical housecraft advisers from all parts of the country attended.

Mr. V. W. Dale, director and secretary of E.D.A., was in the chair on the first day, and Mr. W. S. Lewis, chairman of the Midlands Electricity Board, gave the opening address. He said that women in the electricity supply industry constituted its " strategic force " in the task of building up the domestic load to keep pace with the industrial load and so help to achieve the vital balance of power. Development of the domestic load was essential because efforts to keep electricity prices down depended largely on a varied demand which would keep generating plant fully occupied at different times of night and day.

After an interval during and just after the war, domestic development was now taking place and making its contribution to the achievement of the balance of power. Electric cookers were now going into the homes at the rate of 250,000 a year, the highest rate ever recorded, refrigerators at 40,000 a year and water heaters at about 170,000 a year. It was, however, necessary to sell a great many more domestic appliances before this business became comparable with the growth of the industrial load. The public now accepted that electricity would do everything in the home that was claimed for it. The emphasis to-day was not so much on educating the housewife as on getting her to buy the appliances that she needed. The importance of women in this sphere was obvious. To be successful in this role they must be able to meet and talk to housewives in all walks of life in simple language, avoiding technical terms, about cooking, lighting, hot water supplies, home laundry, refrigeration, cleaning and other household subjects.

Mr. W. S. Lewis (chairman, Midlands Electricity Board) addressing the gathering at the opening session. Seated is Mr. V. W. Dale

The Midlands Electricity Board, had now started to give special training to men and women joining its sales staff. This was a new venture and they hoped to improve and extend these training courses. Such training was essential if the best possible service was to be given to the public by this great and growing industry, in which " unit " sales last year totalled nearly 56,000 million and which had generating plant with a capacity of 18,256 MW that was being increased by about 1,500 MW per year. Ahead lay a big development programme which included nuclear energy generating stations, and the certainty that more and more electricity would be needed in the factories, on the farms and in homes in both town and country. He felt sure that as this development took place women, who had done such valuable work for the industry in the past, would be of even more value in the future.

Mr. Dale briefly described the work of E.D.A. and how it assisted the demonstrator, and in the afternoon Mr. R. Harvey (E.D.A.) spoke on the work of the E.D.A. testing house.

In presenting a paper on " Selling Electricity Through Kitchen Planning," Mr. A. L. Osborne (E.D.A.) said that the majority of kitchens were still quite hopeless. The attack on kitchen planning must proceed simultaneously on two fronts—the architect-builder and the owner-occupier. Basically it came down to keeping doors and windows at least one foot, preferably two feet, from corners so that equipment could go right up to the end wall, and seeing that there were useful unbroken stretches of wall. Then they could find room for a larger and more efficient cooker, a refrigerator, a washing machine, a drying cupboard and counter space for small appliances such as a food mixer. If the room was properly arranged a large floor area was not required. To the owner-occupier, probably with a poorly planned and equipped kitchen, they had to show how electrical fittings and appliances could be installed without tearing down the house and starting again.

In the evening the delegates went to the Institution of Electrical Engineers to hear Miss M. J. Cumming give the Caroline Haslett Trust Exhibition Lecture.

Wednesday's proceedings opened with Miss M. E. Bailey (E.A.W.) speaking on the laundry section of the electric home. She claimed that whether the electric home laundry was but a corner of the kitchen, or a separate utility room, it was the cheapest, most efficient and most pleasant to use. The selective use of electricity could convert the labours of wash-day to a pleasant pastime. Electrical appliances were available to perform every task necessary for laundry in the home. Washing, rinsing, and drying

could be carried out in the absence of the housewife. The tumbler dryer delivered articles so wrinkle-free, that ironing was unnecessary for many of them. Sheets could be ironed by the yard " while-you-wait " using the rotary ironer, while the steam iron did away with much of the need for damping. A complete laundry outfit might be built round the item first purchased. Miss N. Kenyon, in an interesting talk, gave some showmanship ideas for demonstrations.

Thursday morning's proceedings were held at the Institution of Electrical Engineers, Miss V. Norvick (assistant secretary, E.A.W.) taking the chair.

Aids for the disabled housewife was the subject of the talk given by Miss G. P. MacCaul (occupational therapist, King's College Hospital, London). She said that something more was needed than the facilities available in treatment departments in pioneer hospitals where domestic retraining units had been set up. These could only touch the fringe of the problem, but they had proved that disabled housewives could be helped to " make do." Adaptations could be made to existing home equipment and new methods of working could be thought out for the individual.

Miss Margaret Leader (chief housecraft adviser to the General Electric Co., Ltd.), made a survey of what was being done for the blind housewife. She explained that the recent introduction of automatic controls led to an increasing number of blind users requesting modifications to their cookers. They found that the work of converting the cookers was costly, but when one of their service engineers evolved a cooker with special controls for the blind, the company decided to make it available for the blind at the same price as its standard counterpart. The controls on this cooker were so arranged that they could be used by sighted and unsighted persons. An instruction book in Braille was supplied with the cooker.

In dealing with the effects of bad lighting, Mr. W. Robinson (lighting officer, E.D.A.) said that it was not generally appreciated that electric light was probably the only commodity or service left in the world that actually cost less now than at any other time in history. There were more than 12 million British homes with electric light, and 90 per cent of them were either very poorly lighted or could be better lighted. Very few realized that most people spent almost 50 per cent of their active home life under electric light. Health and well-being depended more on lighting than was generally realized. Bad lighting led to reduced enjoyment of home life, more fatigue, eyestrain and nervous troubles. Unfortunately, people generally were in " the candle and oil lamp " era in their ideas on lighting. The average private householder in this country used less than 200 kWh a year for lighting, which cost less than £1 for electricity for the whole house. The ordinary householder was not getting what he should out of electric lighting, not because he could not afford it but because he did not realize what he was missing.

Mr. T. O. Freeth (E.L.M.A.), who followed Mr. Robinson, dealt with decorative lighting in the home and showed by lantern slides of his home in Brighton, what could be accomplished by the proper application of light and correct types of fittings.

During the week written questions on matters arising at the conference and problems encountered by delegates were submitted, and on Friday morning, at the Connaught Rooms, these were dealt with by experts, a lively discussion ensuing.

The conference concluded with a luncheon over which Mr. S. F. Steward (chairman, E.D.A. Council) presided. In a brief speech Mr. Steward expressed on behalf of E.D.A. its gratitude to the Boards for their support and to the housecraft advisers who had attended the conference. He said they would go back to their jobs encouraged by what they had heard during the week. The subjects discussed had covered the whole field of domestic electrification. It was their job to sell the electrical way of life and so raise the standard of living. Electricity would soon be the main source of power in every phase of life and there were tremendous opportunities ahead.

Electricity Supply Inquiry

Electrical Trades Union's Evidence

FOUR aspects of the nationalized industry are dealt with in the Electrical Trades Union's memorandum of evidence presented to the Herbert Committee which is inquiring into the electricity supply industry. They are consultative and advisory councils (joint consultation); consumer consultative councils; contracting departments; and power to manufacture electrical plant and equipment.

The Union's criticism of joint consultation and consumer councils stems from the thesis that " the Electricity Act centralized power and control over the whole of the industry in the British Electricity Authority." Power at the centre carried as its corollary lack of power on the periphery. As a consequence, the provisions of the Electricity Act, which established joint consultation and the consumer consultative councils, were so designed as to safeguard and prevent any encroachment upon centralized power.

In joint consultation, the Union states, the unions have no power to make decisions and no power to follow recommendations through to their effective application. The last word rests with the Central Authority. The Union says that the advisory committees are rapidly being transformed into " efficiency committees." It recommends that discussions should be started on the National Joint Advisory Council, with a view to proposing an amendment to Section 53(b) of the 1947 Electricity Act. These discussions should have regard to the desire of the workers and the trade unions for equal executive power with the Electricity Boards and the Central Authority in reaching decisions and making recommendations; the need for the establishment of a board of reference to decide on unagreed proposals and the failure of Area Boards to accept and operate recommendations considered by the National Joint Advisory Council to be in the best interests of the industry and the workers; and the institution of an effective line of communication from the local advisory committees to the N.J.A.C.

Similar weaknesses are to be found in the machinery of consumer consultation. Power to make effective decisions is vested solely in the Area Boards and the Central Authority. The E.T.U. thinks that powers should be given to the councils particularly to consider matters affecting the generation of electricity and suggests that the functions of the councils be extended to take in criticism of the management, either by presentation of memoranda to the Area Boards or to the Central Authority or to the Minister of Fuel and Power or to all three.

The Union says that the Central Authority and the Area Boards have preferred to come to arrangements with the Electrical Contractors' Association rather than develop and extend their own contracting departments. It recommends, as a first step, that the Central Authority should submit, every year, in its annual report to the Minister of Fuel and Power, a detailed statement of how the B.E.A. and the Area Boards are implementing the electrical contracting powers vested in them by the 1947 Act. Also linked with the six-year generation plan there should be a contracting and installation programme.

The Union thinks that it would not be practical for the B.E.A. to manufacture electrical plant, fittings and equipment. It favours nationalization of the firms engaged solely or mainly in the manufacture of heavy electrical plant and equipment and makes particular reference to the cable making industry.

ELECTRICITY IN COAL MINING

2.—Underground Switch and Control Gear

By P. N. WYKE, B.Sc., M.I.E.E., M.I.Min.E.*

THE date of electricity's advent as a power source below ground is open to some argument, but it is on record that in the late nineties it was in use for driving machinery at the coal face. The largest number of motors in use to-day is for transporting coal (i.e. conveyors and haulage), pumping, coal-cutting and drilling. For the purpose of this article the equipment is divided into two sections—that within 300 yd of the coal face and that outside 300 yd of the coal face.

Regulation 132 of the general regulations for the installation and use of electricity made under the Coal Mines Act, 1911, and still current under the 1954 Act, requires that:

"In any part of a mine in which inflammable gas, although not normally present, is likely to occur in quantity sufficient to be indicative of danger, the following additional requirements shall be observed:—

(i) All cables, apparatus, signalling wires and signalling instruments shall be constructed, installed, protected, worked and maintained, so that in the normal working thereof there shall be no risk of open sparking.

(ii) All motors shall be constructed so that when any part is live all rubbing contacts such as commutators and slip-rings are so arranged or enclosed as to prevent open sparking.

(iii) The pressure shall be switched off apparatus forthwith if open sparking occurs, and during the whole time that examination or adjustment disclosing parts liable to open sparking is being made. The pressure shall not be switched on again until the apparatus has been examined by the electrician or one of his duly appointed assistants and the defect, if any, has been remedied or the adjustment made."

The criterion as to whether electricity may be used in any part of the mine is that the proportion of inflammable gas in the general body of the air in that place does not exceed 1·25 per cent; if it exceeds this then the supply must be cut off immediately. It is customary to work well below this figure. Under modern mining conditions and systems of ventilation, the regulations are taken to mean that where electricity can be used at the coal face in a safety lamp mine, the special requirements need apply only within 300 yd of the coal face. In the intake airway, the clean air coming down from the surface to the face presents little hazard. Any gases coming off the coal face or the waste are sufficiently diluted as to be innocuous after they have travelled 300 yd from the coal face along the return airway.

Apparatus used outside this 300 yd limit is generally of conventional design but of more robust construction to withstand rough usage and so is dismissed in this article with no more than a passing reference. Within the 300 yd limit, apparatus has to be either flameproof or intrinsically safe, and of extremely rugged construction. The flameproof motors used are of conventional design (generally built to B.S. 741) but, in addition, there are particular requirements as to cable entry and type of cable gland. As this article deals with apparatus peculiar to the coal mining industry, it will be confined to control gear and flexible cables.

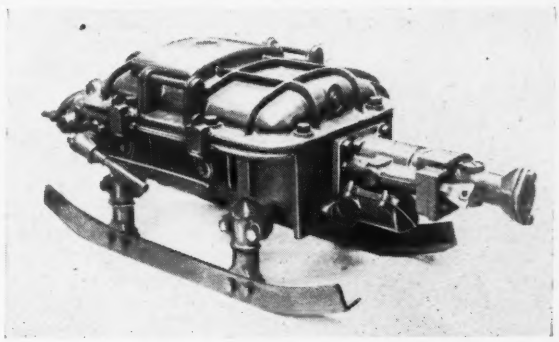
Electrical energy is taken below ground at 3·3 kV, to a distribution substation at the pit bottom. Although the short circuit capacity of the line at this point is generally limited to 25 MVA, it is being found inadequate and on some of the larger new developments short circuit capacities of 50 or 75 MVA are being included. From this point, cables of the order of 0·1 sq in paper insulated lead covered double wire armoured (B.S. 760) are taken out to the various districts. These terminate at an oil switch feeding a local transformer of between 100 and 300 kVA, the usual size being 150 kVA, although this is tending to increase. As no suitable flameproof transformer of this size has been developed, the transformer used must be situated more than 300 yd from the coal face which itself is continually receding from the transformer, thus giving rise to a condition where the voltage drop beyond the transformer becomes excessive and the transformer has then to be taken along the roadway until it is once again 300 yd from the coal face.

Gate-End Boxes

From the transformer, power passes to an oil switch or air-break section switch, and thence to the "gate-end boxes" which are only a short distance from the coal face; these are starters with remote control but far more complicated than a normal starter. The first record of a gate-end box dates from the late nineties. It consisted of a series of separate boxes containing a double-pole switch and a double-pole fuse. In addition there was a cable gland mounted on a dividing box on which was a plug and socket (see Fig. 1). These separate units were mounted on pairs of angle irons and interconnected through conduit piping. They were later superseded by the oil switch and as late as 1930 the predominant method of control was still a switch fuse or oil switch. Some use was being made of gate-end boxes, as we now know them, but discussion was still going on within the industry as to whether oil-break or air-break switches were more suitable for controlling coal face machinery.

Although the hazard attached to the use of electricity

Fig. 1.—Double-pole switch fuse for coal face machinery—circa 1900



* Mr. Wyke is Electrical Engineer (Mining) to the National Coal Board.

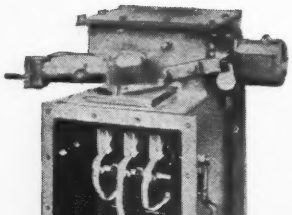


Fig. 2.—Gate-end box—circa 1930

below ground was recognized some time before 1910, it was not until 1922 that the systematic testing and certification of flameproof and intrinsically safe apparatus was organized in Great Britain by the Mining Department of Sheffield University. The issue of " flameproof " certificates for enclosures initiated the development of special apparatus for mining and although there was some distinct improvement over the next eight or nine years, progress was still slow.

In 1931 " flameproof " test and certification was taken over by an official Government testing station and tremendous impetus was given to the improvement of quality and design of special mining apparatus. At about this same time, an air-break gate-end box (Fig. 2) was produced providing the following features and facilities:—(1) No volt protection; (2) overload protection on two phases; (3) earth leakage protection; (4) earth continuity; (5) a provision that the plug at each end of the cable must be pushed well home before the contactor could close; (6) a provision for controlling a coal cutter from a switch mounted on the coal cutter, and stopping it from the gate-end box; (7) isolating switches both at the gate-end box and on the machine; (8) confining the making and breaking of currents to the gate-end box where the contacts were most accessible for cleaning or replacement; (9) a locking device to prevent the machine from operating until a fault had been cleared.

Fig. 3 shows that the gate-end box has changed little in essentials over the past 20 years, and its features as listed above are very similar to-day. The change has been in the individual components, the interlocking, and the provision of intrinsically safe remote control circuits.

In 1950 the National Coal Board issued the following standard specifications:—Size 1—Flameproof gate-end box with a contactor rating of 80 A; Size 2—Gate-end box with a contactor rating of 150 A; flameproof air circuit breakers with a rated carrying capacity of 200 A; air-cooled flameproof single-phase lighting transformer gate-end box; 50 c/s drill gate-end box; and 150 c/s drill gate-end box.

The primary purpose of the specifications was to ensure that units produced by different manufacturers could be coupled together easily and quickly; however, it was soon discovered that the essential dimensions could not be specified unless details of the requirements were also specified. Attempts have been made to incorporate what were thought to be the best features of all gate-end boxes in existence at that time.

Remote Control Circuits

Since the specifications were issued, more detailed consideration has been given to the requirements of remote control circuits and the following picture has emerged. Electrical interlock between the gate-end switch and the coal cutting machine was considered as early as 1908 but not introduced until 1920. Remote control was introduced in 1928 and used the normal control circuit with a low voltage current. In 1937 an investigation commenced following the observation of sparking between the earthed case of a drill and some conveyor pans when the remote control circuit was closed momentarily. It has been, and still is, customary for the return path of the remote control circuit to be through the earth core of the cable. It was discovered, however, that if, owing to high resistance connector joints, the earth return was not truly continuous, and an alternative path could be obtained through the main body of earth, sparking could occur at the point of transfer to the alternative earth, and could be a source of danger.

This led to the development of the intrinsically safe remote control circuit. All remote control circuits have now to be certified intrinsically safe, i.e. they must be incapable of igniting the most combustible air/methane mixture should the circuit be broken or short circuited. (See B.S. 1259).

Circuits were evolved by different manufacturers using numerous types of safety device until by 1945 difficulty was being experienced by users because the equipment at the remote end of the cable varied so much that each circuit required its own particular remote apparatus. Coupled with this, the testing authority found that the arc produced by slow moving electrodes had a greater ignition hazard than that provided by fast moving electrodes. Re-testing of previously certified control circuits showed that many were unsafe when tested under the new circumstances. In 1947 a committee composed of the National Coal Board, the manufacturers concerned, the testing authority and the mines inspectorate set out to evolve a standard remote control circuit. Many circuits were examined and a small number selected for laboratory and subsequent prolonged field trials. Although some of the trials were successful, it was found that further developments had occurred in the meantime and it appeared that finality had still not been reached. Some degree of standardization was becoming urgent; it was therefore decided to attempt to standardize the apparatus at the remote end of the cable from the gate-end switch and leave the actual circuit to the ingenuity of the manufacturer. Investigation on these lines is still proceeding.

Earth Leakage Protection

It has for many years been customary in British mines to connect the neutral point of the inbye transformer solidly to earth. Thus the fault current which can flow is limited only by the fault resistance, the impedance of the cable and that of the transformer and currents of some hundreds of amperes can flow. It is not generally possible under such conditions to set the leakage relay of a core balance transformer to operate at much below 5 A; it has been done, but involves very close control of transformer manufacture, resulting in an expensive product.

A new system was developed in about 1947 whereby the neutral point of the transformer could be coupled to earth through a spark gap or other over-voltage protective device. At each switch and gate-end box on the secondary side of the transformer the three phases are starred through an impedance of approximately 20,000 ohms and coupled to earth through a relay consisting of a thyratron valve. Any earth current which flows, operates the valve to trip out the contactor. It was found that although operation could be achieved with quite low earth currents it was in practice preferable to limit the operating current to about 8 A.

The maximum current which could flow would be of the order of 16 A per gate-end box. This would mean that with half-a-dozen gate-end boxes and a main switch, the maximum current through the fault would be of the order of 112 A. This current is not necessarily intrinsically safe; nevertheless it was thought to be a big step forward

as the voltage and current to earth are only on the threshold of lethal power. It was, however, soon discovered that the earth leakage was so sensitive that it did not permit normal operation of the mine; even condensation on a plug resulted in operation of the protective device. The plug had only to be wiped for normal operation to be resumed but this transient fault condition "brought out" every gate-end box on the system as well as the main switch.

This condition has been overcome by inclusion in the gate-end box of a fault search circuit consisting of a transformer on the incoming side of the contactor to provide a low voltage which is applied to the three phases through the starred impedance, when the contactor is de-energized. The other leg of the transformer is connected to earth. If an earth fault persists on the circuit the small current flowing through the fault and back through the transformer passes through the thyratron relay and so prevents the contactor being reclosed. All other gate-end boxes can again commence operation as soon as the individual remote control switch is moved to the "start" position. Thus, although the box trips out, the operator has become accustomed to trying his remote control switch and if all is well the machine will re-start. The faulty box will be locked out and will not operate until the fault is removed. The voltage and current required for the earth lock-out are so low as to be almost intrinsically safe and far from lethal. Varying cable capacities prevent a condition of true intrinsic safety.

In order to prevent the opening of the main switch on every earth fault, a time delay was inserted in the earth leakage trip on the transformer switch. This delay was so small (2-3 cycles) that it was considered the advantages accruing were sufficient to warrant what might otherwise have appeared to be a retrograde step. The spark gap or other over-voltage device ensures that should the main transformer break down between windings there will be a path to earth of a sufficiently low resistance to operate the earth leakage device on the high voltage switch supplying the transformer.

Other systems using larger currents have since been devised employing electro-magnetic relays instead of the thyratron valve. These have in the main been successful but can suffer from a defect when there is a high resistance fault. If the earth leakage settings are not sufficiently sensitive it is possible for a circuit to trip out on earth leakage and, as the voltage has been reduced to a low value on the earth lock-out, for insufficient current to be flowing for the earth lock-out to operate, although there is still an earth fault on the circuit. In such cases it has been necessary to return to the old method of mechanical lock-out and hand reset after an earth leakage trip.

It is a requirement of flameproof enclosure that the structure with the cover in position shall withstand without deformation a steady pressure of 50 lb/sq in. In order to achieve this it had been considered necessary, until the issue of the N.C.B. specifications, to have a large number of fixing studs to secure the cover to the case. Additionally it had been necessary to shroud or otherwise protect

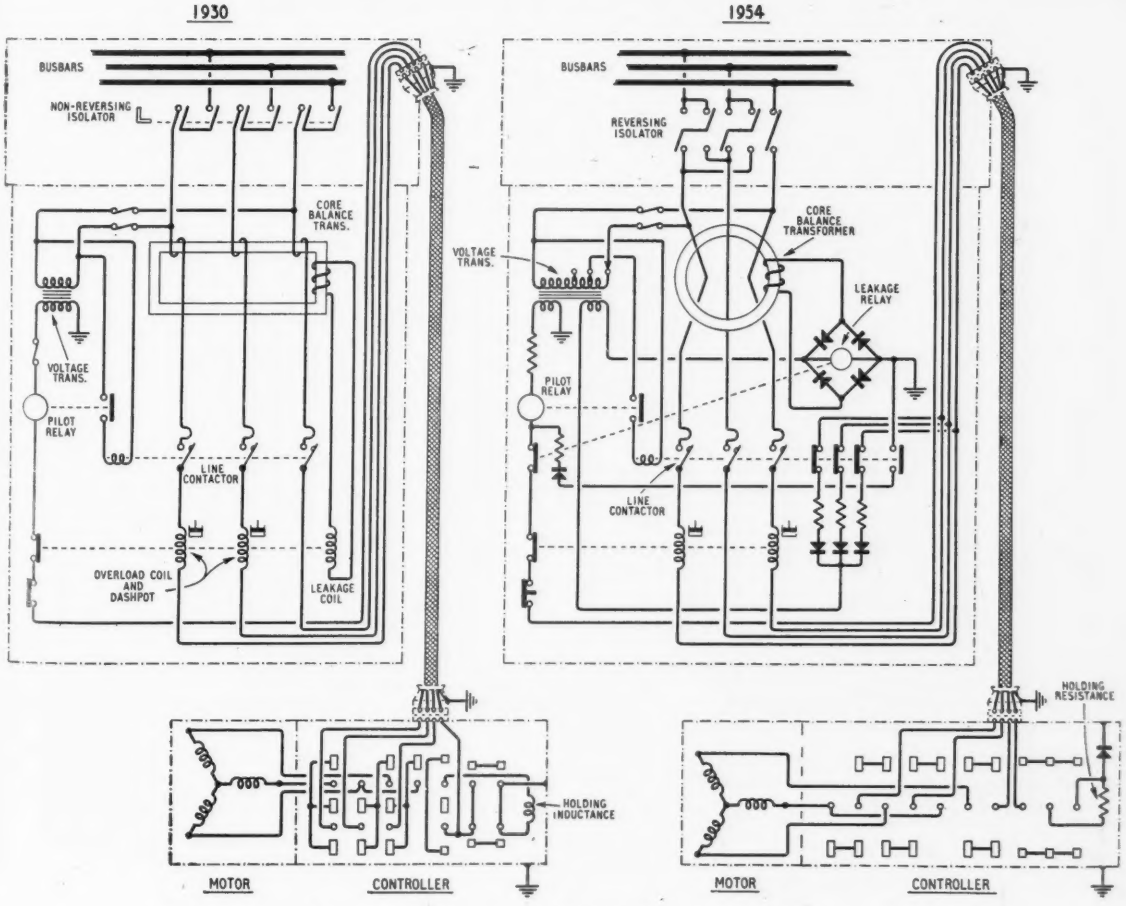


Fig. 3.—Circuit arrangements of gate-end boxes, 1930 and 1954

these bolts so that they might be unfastened only by a special tool. Under mining conditions, with low roofs and narrow roadways, it was a tedious job to remove and replace a front cover and if a bolt became lost or damaged it might take some hours, depending upon the distance of the gate-end box from the shaft, before a replacement could be secured. One of the alternatives provided by the specification was a means of securing by one bolt. As a number of different single bolt fixings are now in use the major types are described below:—

(1) This is built on the principle of a safe door. Contrary to usual practice the flameproof flange is axial. The door is hinged and the locking arms, operated by the central handle, move radially from the body. It should be noted that the flameproof path does not depend on the bolt being completely home (Fig. 4).

(2) Similar to the previous example but the door is secured by a centre screw; it should be noted that this has to take the full shock on its threads should an internal explosion occur (Fig. 5).

(3) A more conventional wedge action: after the door has been swung into position it is forced down into place by the operation of the turnkey at the top of the door. The flameproof path in this case depends upon the screw being completely home although there is no strain on it should an explosion occur (Fig. 6).

(4) This also involves a wedge action. The radial arms move outwards when the handle is turned, sliding into the wedge portion inside the case to pull the cover into place and secure it there. The wedge portions are removable for maintenance or replacement and for conversion to multiple fixing if desired (Fig. 7).

(5) This is not a single bolt fixing in the true sense but a development which is worthy of note. All bolts are captive in that they cannot be completely removed from the housing. The cover is placed in position, the bolt head passing through the large hole in the cover; the cover is then moved downwards, the bolt sliding into a slotted portion (Fig. 8).

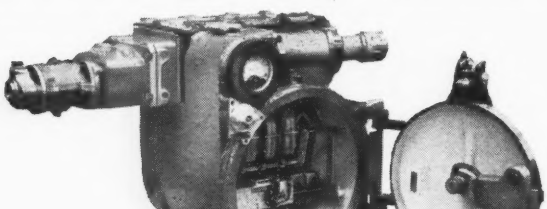
Trailing cables for mining purposes are described in great detail in B.S. 708, and for medium pressure power purposes may be described as unique. Apart from d.c. cables, which are rapidly going out of use, there are four main types:—

The first is for use with transportable apparatus and has five cores, i.e., three power, one earth and a pilot. Each power core is insulated and then surrounded by a copper wire screen, the whole tough rubber sheathed and having a further sheath of polychloroprene served overall. Alternatively the copper screen may be placed between the tough rubber sheath and the polychloroprene sheet. There are two forms of assembly: all cores laid round a cradle centre; or the earth core buried in the cradle centre itself. There are also in use some experimental cables with the protective copper screen replaced by conductive rubber. These have not been entirely satisfactory and are at present limited to systems where the earth fault current cannot exceed 0·25 A, such as have been described earlier in the article. The above types of cable are used for motors which are moved during the course of their normal operation, excluding hand-held drills, etc.

The second type, for use with semi-fixed apparatus, is used for feeding motors which are static during their normal operation but may be moved at intervals of, say, 24 hours. These cables, described as pliable armoured flexible, consist of three, four or five cores, i.e. three power, an earth core and a pilot as necessary, the whole being laid round a cradle centre, sheathed, steel wire armoured and sheathed overall with polychloroprene.

The third type, trailing cables for use with drills, have five cores, i.e., three power, an earth and a pilot core. Three varieties are of 0·01 section for all cores and laid up on the same pitch circle, and have a lay of 12, 6 and 4 times the pitch diameter. Another type has three power cores and a pilot core all of 0·007 sq in cross section and laid in a close helix round a 0·0225 sq in earth conductor. The lay here is approximately two and a half times the pitch diameter. It should be noted that these cables have no protective screen or armouring as they have to be both light and flexible.

The last type consists of pliable armoured flexible cables for remote control. These consist of two or three cores of equal cross sectional area either 0·0048 or 0·007 sq in laid up, tough rubber sheathed, armoured with steel wire armour, and polychloroprene sheathed overall. The purpose of the polychloroprene sheath in each case is to ensure



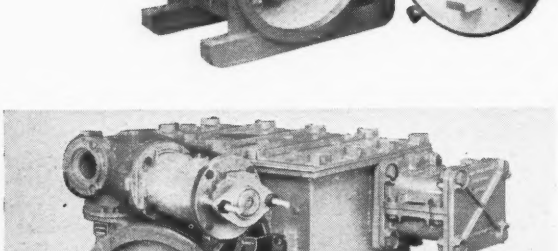
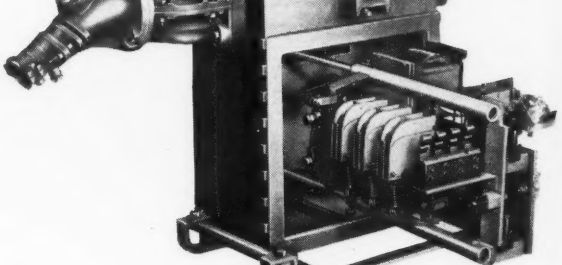


Fig. 4 (left).—Example of single-bolt fixing, with axial flameproof flanges. Fig. 5 (below left).—Example of single-bolt fixing, with centre bolt. Fig. 6 (below).—Example of single-bolt fixing, with wedge action



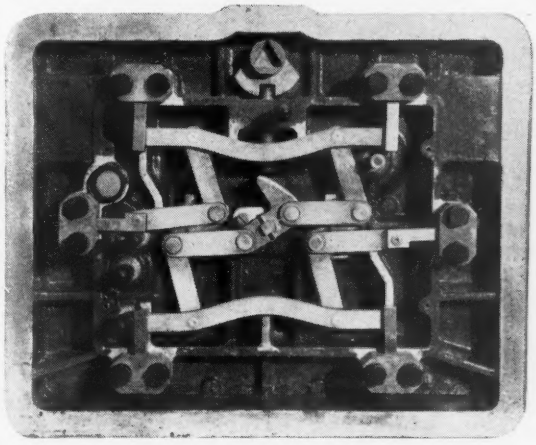


Fig. 7.—Interior of door, with shoot bolts

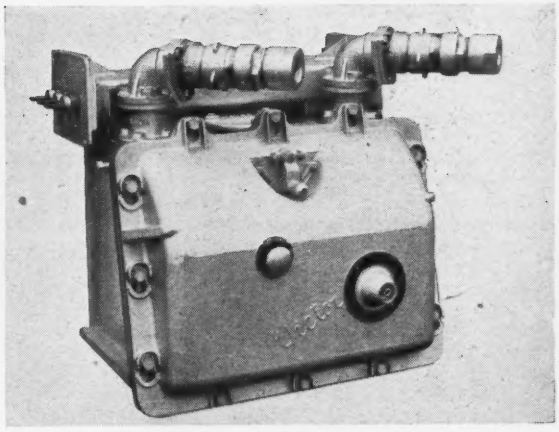


Fig. 8.—Captive bolt fixing

that should the cable catch fire a flame will not travel along its length. The arduous duties imposed on these cables may be judged by the fact that those which are not wire armoured have frequently to be taken out of service after three months and moved to a surface workshop for complete inspection, overhaul and repair; and this, despite the fact that they are up to 2in diameter and 200 yd long, and that their removal may involve a journey of up to five miles underground.

Future Developments

Save for some radical change in the principle of operation, it is unlikely that the gate-end box will change substantially in the foreseeable future. Meanwhile, the following points require development:—

(1) Unit components inside a gate-end box must be of the plug-in type, to facilitate replacement.

(2) Relays should be in a transparent case, and sealed to prevent interference by other than specific maintenance personnel.

(3) A lightweight material is sought, in place of the heavy steel case generally used to enclose gate-end boxes. Aluminium has been used, but in view of the spark hazard encountered on impact between rusty steel and aluminium, its use on the coal face is restricted, and although gate-end boxes are not now used in the prohibited area, it is thought that aluminium cases should be gradually eliminated.

(4) It is anticipated that ultimately the use of electronics will eliminate the need for a remote control core in the cable, as control will be achieved by superimposing signals on the power cores of the cable. Selenium cells are already in fairly common use for counting tubs and opening doors, etc., and although efforts have already been made, with some success, to introduce electronic principles into remote control circuits, these cannot be said to comply satisfactorily with the prescribed boundary conditions.

(5) Machinery at the coal face has, until now, been limited to 650 V, but in view of the increasing size of motors underground, the cables required have become so unwieldy that it will soon become imperative to relax this voltage limitation. Should a voltage of 1,100 be permitted on the coal face, it will inevitably bring with it new problems in switch and control gear.

(6) The drill gate-end box needs the following features: a satisfactory design of over-current relay with time delay characteristics (thermal overloads are not satisfactory owing to the long cooling period necessary, and the magnetic overload in its present form has not the correct characteristics); instantaneous short circuit protection which can distinguish between the starting or stalled conditions; single-phase protection to guard against single cores pulling out from their sockets.

The two million h.p. of motors installed below ground gives some indication of the importance electricity plays in the winning of coal. As the thicker coal seams are exhausted and output has to be maintained from thinner seams, so the h.p. of motors, especially at the coal face, will increase still further. It is a constant challenge to the electrical engineer to provide safe machines of a high h.p. suitable for mine conditions and to maintain them in safe working order. This article has given only an outline of some of the major pieces of equipment; there are many others, such as exploders, telephones, signal lights, signalling apparatus and many types of protective apparatus, all of which play their part although there is insufficient space to describe them here.

E.R.A. Reports

Flameproof Equipment.—Report No. G/T298 of the British Electrical and Allied Industries Research Association is on "Flameproof Electrical Apparatus: Flanged Joints One Inch in Radial Breadth in Mixtures of 'Standard' Town's Gas and Air," by T. J. A. Brown, B.Sc., A.Inst.P., and N. Simpson (price 7s 6d from the Association at Thorncroft Manor, Dorking Road, Leatherhead, Surrey). For explosive mixtures of "standard" town's gas and air, ignited in a bronze sphere having horizontal equatorial flanges 1in in radial breadth, the most incendive internal mixture is that containing 18·5 per cent of town's gas by volume. The most readily ignitable external mixture contains 17 per cent of standard town's gas. With this combination of internal and external mixtures, the maximum experimental safe gap on a criterion of n=20 and k=0·001in, is 0·024in, and the statistical maximum safe gap, reassessed, is 0·018in.

The subject of Report No. G/T299 by T. J. A. Brown (price 4s 6d) is "Maximum Experimental Safe Gaps. A Note on the Emission of Flame through Flange Gaps." The fundamental difference between the British and American tests on flameproof equipment is the criterion of flameproofness: the non-appearance of flame external to the apparatus is the American criterion, whereas in Britain the non-ignition of an external mixture is the standard adopted. The tests described illustrate the difference between the two standards.

Slow Electrons.—Report No. L/T299 by S. Zienau (price 12s 6d) is entitled "On the Motion of Slow Electrons in Polar Materials." The technique of canonical transformation is applied to various problems connected with the behaviour of a slow electron in an ionic crystal. The connection with previous work by Guarari is discussed.

Recent Lighting Installations

ON the opposite page we illustrate from numerous photographs we have received some typical examples of modern lighting installations, from which it will be seen that not only has adequate illumination been obtained, but also, by collaboration between the architect and the lighting engineer, the installations conform to the architectural design of the premises.

The new office block recently completed by the AC-Delco Division of General Motors for their Southampton factory is a good example of modern practice in office layout. Three different forms of illumination are provided by "Ediswan" fittings. For the managing director's office a hollow square laylight panelled with diffusing glass was fitted flush with the acoustic tile ceiling. The panels conceal eight 125 W 8ft "new warm white" fluorescent lamps which give an initial intensity measured at table level beneath the fitting of 75 L/sq ft. Separate switching provides three lower levels of illumination. For the general office individual recessed reflectors each for one, two or three 80 W "new warm white" fluorescent lamps were used, giving an initial intensity of 30 L/sq ft on the working plane. Detachable louvres and internal panels in the reflectors allowing access from below to all components ensure minimum maintenance costs. For the drawing office cold cathode lighting is used, four lines of tubes in continuous recessed reflectors with detachable louvres giving an initial intensity on the working plane of 75 L/sq ft. The architects were Howard, Souster & Fairbairn, and the contractors, John Hearson & Co., Ltd.

Food and Departmental Stores

The lighting of the food store of David Greig, Ltd., Canterbury, illustrates the excellent results which can be obtained by early co-operation between architect and lighting engineer. The architect advocated some form of indirect lighting mounted at a level which would simplify installation and maintenance. Philips "Weybridge" spotlight fittings with 500 W internally silvered lamps were installed. The fittings provide a maximum beam intensity in the order of 11,000 candelas and a beam angle of approximately 60 deg. The fittings are mounted 9ft from the floor and 6ft apart, with the training angles arranged to keep the ceiling brightness as uniform as possible. The fittings blend with the general design of the interior. The lighting was the subject of close co-operation between Robert Paine & Partners, and the lighting design service of Philips Electrical, Ltd. The installation was carried out by Electron Engineering, Ltd.

The new departmental store of Owen Owen, Ltd., Broadgate, Coventry, which was recently opened by the Lord Mayor of the city, is the most striking building in the new Coventry. It was designed by Rolf Helberg and Maurice Harris, and the electrical contractors were Lee, Beesley & Co., Ltd. The lighting not only brings out the architectural features and harmonizes with the decorative colour schemes, but also gives a complete and pleasant change of effect as the shopper passes from floor to floor. Most of the front of the building is a great expanse of glass, so that the lighting on each floor, combined with the neon treatment and the efficient shop window lighting, provides a brilliant façade to the new city centre after dark.

To achieve this result use has been made of both tungsten and fluorescent media, a large number of the fittings being specially made by Lee, Beesley & Co., Ltd., and by the General Electric Co., Ltd. The illumination of the show windows has been obtained with a novel method of supplementing "Osram" "new warm white" fluorescent tubes at strategic points with coloured tubes and high intensity spotlights fitted with grippers for easy transfer of position. There are four "Claudgen" neon signs reading "Owen Owen." In addition "Osram" cold cathode tubing in blue which runs along the entire length of the fascia on the front canopy of the building silhouettes the "Owen Owen" lettering on it. Much of the electrical equipment, including all the control gear for the fluorescent lighting, the 1½ miles of fluorescent tubes and 142 miles of v.r. cable, was supplied by the G.E.C.

For the new modern building of the Loewy Engineering Co., Ltd., at Poole, Dorset, the architects, Farmer & Dark, chose the new "Ekco" F51046 fluorescent lighting fitting for all the drawing offices throughout the building. This particular fitting was designed by the Building Research Station and developed and produced by Ekco-Ensign Electric, Ltd. The complete unit comprises a ceiling box containing control gear, spine, coloured transverse metal louvres, and diffusing opal perspex side screens. The fitting, supporting a single 80 W 5ft "Ekco" white (3,500°K) fluorescent lamp, has a pleasing modern slim appearance, high efficiency, low brightness and low weight.

Aerodrome Offices

The entrance hall and private and general offices are among the sections of the Leavesden Aerodrome new offices of the De Havilland Engine Co., Ltd., which are illuminated by means of Holophane tungsten lighting units. Circular "Controlens" units No. CV.453 have been recessed into the ceiling in the entrance hall, and have been continued under the entrance canopy for exterior lighting.

On the first floor landing above the main entrance hall 14in "Steplite" ceiling fittings, each with three 100 W lamps, have been installed centrally in the 3ft diameter glass laylights in conjunction with prismatic glass translucent reflectors fixed above, to minimize any possibility of shadow. In the first floor corridors (east and south wings) "Lentilite" units have been used in conjunction with circular bulkhead units. The general offices on the ground floor (south and east wings) are lit throughout by Holophane "Correctalite Lumilux" 200 W fittings, and tungsten units have also been installed in directors' and senior executives' private offices, dining room, stairways and other parts of the building. The installation was planned by Holophane illuminating engineers in collaboration with the engineers of the De Havilland Engine Co., Ltd.

A good example of lighting in a modern car showroom is the scheme recently completed by Crompton Parkinson, Ltd., at the Leicester premises of Cox's Motors, in Conduit Street, London. Both interior and exterior features of the vehicles are brought out to good advantage, and of particular note in this installation is the ample overall illumination provided, without excessively bright specular reflections on the chromium and other highly polished surfaces. For the main overhead lighting in the showroom, which is 50ft long by 30ft deep, use has been made of fifteen louvred fluorescent fittings, recessed into the ceiling for neat appearance, to give an average intensity of illumination of 12 ft-candles. Additional lighting has been provided by batten fittings above the showroom windows.

Some 60 "Mazda" 80 W flameproof fluorescent fittings (British Thomson-Houston Co., Ltd.) have recently been installed on two oil jetties at Coryton Refinery, Essex. The fittings are mounted in banks of one, two or three, on specially designed frames, and have anodized aluminium reflectors to provide a cut-off beam from each bank.

One of the chief requirements of a lighting scheme for any modern drawing office, is uniformity of illumination throughout the whole department. An example of good, uniform lighting is the engineering drawing office of Robert Boby, Ltd., Bury St. Edmunds. Siemens "Sieray" fluorescent lamp fittings (type 4231.E.) with 4ft lamps suspended on chains are used, individual control of each lamp being provided by an "on-off" cord pull-switch.

EXAMPLES OF GOOD ILLUMINATION (See opposite page)

1. *De Havilland Engine Co., Ltd., Leavesden Aerodrome.* **2.** *Cox's Motors, Conduit Street, London.* **3.** *Loewy Engineering Co., Ltd., Poole.* **4.** *Owen Owen, Ltd., Coventry.* **5.** *David Greig, Ltd., Canterbury.* **6.** *Coryton Refinery.* **7.** *Robert Boby, Ltd., Bury St. Edmunds.* **8.** *AC-Delco Division, General Motors, Southampton*

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COXS MOTORS
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DAIRY PRO
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Wind Power Generation

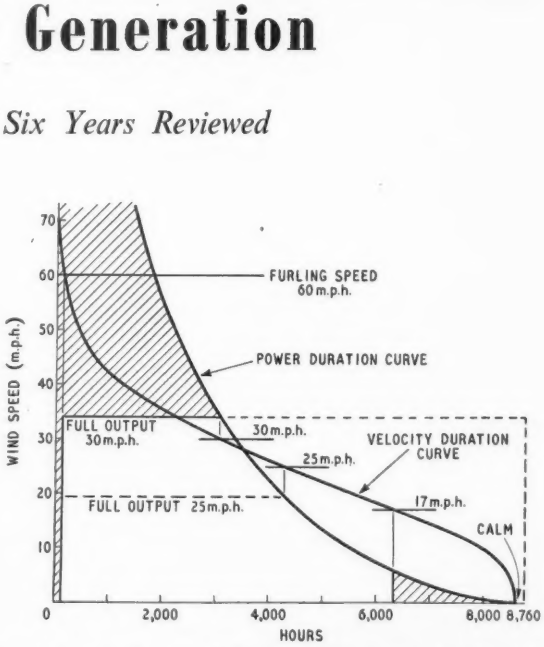
Progress During Past Six Years Reviewed

A SURVEY of wind power development (first mentioned in England in 1191 A.D.) with especial reference to progress during the last six years was made by Mr. E. W. Golding (Electrical Research Association) in a paper presented yesterday (Thursday) before the Supply Section of the Institution of Electrical Engineers.

The formula for available wind power, the author gave as $5\times10^{-6}AV^3C_p$, where A represents the cross-section in sq ft of a wind stream moving with velocity V m.p.h. and C_p represents the power coefficient with a maximum value of 59·3 per cent, which becomes 40 per cent (the power coefficient) after allowing for mechanical and electrical losses. Variations in the annual average wind speed seldom exceeded ±10 per cent of the long term mean, which at the E.R.A. station in Carnarvonshire showed an annual average wind speed of 26 m.p.h. Monthly average mean wind speeds might vary from the annual by 40 per cent.

In Great Britain January was the windiest month and July and August were the least windy. Gust speeds appeared to be unrelated to the annual average. Calm weather often covered a wide area, so the effect of a diversity of interconnected wind generators in securing consistency in electricity output was likely to be small. Direction from which the wind blew for the greatest portion of the year might be only 16 per cent compared with the 12½ per cent for each of the eight principal directions if the wind direction were evenly distributed.

The velocity-duration curve at the Carnarvonshire site, here reproduced, derived from measured hourly wind speeds, gave the number of hours in the year during which the speed exceeded a particular value; the power-duration curve was obtained by cubing the ordinates. The machine was designed to cut in at a wind speed at which its output was only enough to supply its power losses. At the rated wind speed, 5 to 10 m.p.h. above the average mean, the plant produced its full rated power and at higher speeds was controlled by a spill-over governor. The unshaded area under the full output line and the power-duration



curve over the operating range was proportional to the annual output. Velocity-duration curves were of a similar shape for all British sites and average mean velocity provided a sufficiently accurate measure of specific output, i.e. kWh/year/kW, for estimation purposes.

Wind machines were of two main classes, viz. the solid type or " panemone," in which the effective surfaces of the rotor moved in the direction of the wind, and the propeller or wind-wheel type, the rotor of which turned in a plane perpendicular to the wind. The first had a maximum theoretical power coefficient of only 0·33 compared with 0·593 for the propeller type, while its low rotational speed entailed the use of expensive gearing for driving a high-speed electrical generator. The optimum power coefficient for the propeller type (0·4 in practice) when connected to a constant-frequency network, and so running at constant speed, could be maintained only by controlling the variation of blade pitch, the cost of which would probably not be justified.

Investigations carried out by E.R.A. from 1948 onwards

COMPARISON OF DESIGNS OF PROPELLER AERO-GENERATORS

Design	Rotor diameter ft	Rated wind speed m.p.h.	Generator kW	Form of rotor	Control of speed or output	Optimum tip speed ratio	Rotational speed r.p.m.	Height of hub above ground ft	Method of weather-cocking
Russian (Balaclava)	98	24·6	100 (Induction)	3 blades	Variable pitch by flaps	4·75	30	76	Tail vane and electric drive
P. H. Thomas (United States Federal Power Commission)	200	34	7,500 (d.c. converted to a.c.)	Twin, 3-bladed	Speed control (generator field)	9	Variable maximum 42·75	475	Electric drive
United States War Production Board	200	30	1,500 (Induction)	2 blades	Blade pitch control, electro-mechanical	12	50	150	—
Smith-Putnam	175	30	1,250 (Synchronous)	2 blades (rectangular)	Hydraulic pitch control (fly-ball governor)	6	29	110	Yaw vane. Servo-mechanism. Hydraulic yaw motor
Folland (Ministry of Fuel and Power)	225	35	3,760 (Induction)	2 blades, 2 stage taper, 11½ deg twist, fixed coning	Blade pitch control by aileron; start/stop by pilot windmill	9·74	42·5	135 (tripod)	Fantail coupled to bogey wheels through centrifugal clutch on fluid flywheel
John Brown	50	35	100 (Induction)	3 blades, tapered, untwisted; free to cone and drag	Hydraulic (blade pitch)	6·5	130	78	Automatic electric control
Enfield Cables	80	30	100 (Synchronous)	2 hollow blades	Automatic pitch control (hydraulic variable coning)	—	Variable maximum 95·4	100	Self-orienting but assisted by wind-sensitive power control
S.E.A.S. (Danish)	43	28	45 (Induction)	3 blades	Blade-tip rotation (spring)	5·4	56	66	Yawing vane and electric motor drive

had been based on the availability of sites where specific outputs of 4,000 kWh/year/kW could be obtained at rated wind speeds of 30 m.p.h. and the possibility of quantity production at £55/kW of automatically operated groups of aero-generators of 2,000 to 3,000 kW feeding main networks. Taking annual charges at 8½ per cent, such conditions would lead to an energy cost of 0·25d/kWh, compared with 0.41d/kWh as the fuel component of the costs at coal-fired stations.

More than 100 measuring sites had been used by the E.R.A. Out of 65 hill sites of altitudes from 150 to 2,795ft, 39 had annual mean wind speeds exceeding 20 m.p.h. with estimated specific outputs at 30 m.p.h. of from 3,000 to 4,750 kWh/year/kW.

Evidence from abroad suggested that for medium-scale utilization (10 to 100 kW), the cost per kW might be £120/kW, without battery storage, giving random energy for 1·4d/kWh. As fuel savers in conjunction with diesel engines, such aero-generators might be economic at wind speeds above 10 m.p.h., but battery storage to cater for even one-fifth of the annual energy generated would double the cost. For small scale utilization, a representative cost with battery was £200/kW with annual capital charges of 15 per cent, giving an energy cost of 6d to 9d/kWh.

Testing Circuit Breakers

Discussion on I.E.E. Supply Section Papers

THE discussion on the two papers on circuit breakers which were presented before the Supply Section of the Institution of Electrical Engineers on 23rd March (*Electrical Review*, 25th March) was opened by Mr. L. Gosland (Electrical Research Association). The first phase to clear in a three-phase unearthed fault, he said, could be subject to a momentary peak voltage of 1·5 times normal, but this was highly improbable, and to construct a circuit breaker to meet so onerous a test would be expensive. Analysis of fault records for a number of years would show the frequency of faults of this type. A three-phase test gave three shots at the loop to extinguish the arc, whereas a single-phase test had only one. The single-phase test of the breaker was likely to be more severe.

M. Yves Baron (Electricité de France) agreed that standardization of values of rate of rise of recovery voltage and amplitude factors should be based on realistic system conditions. In single-phase testing the authors favoured a reduction of the recovery voltage at 100 per cent duty, which at present by B.S.116 and the I.E.C. and French specifications must be 1·5 times the maximum phase-to-earth voltage. In out-of-synchronism conditions the circuit breaker had to break a current equal to 25 per cent of the rated symmetrical short-circuit current with a recovery voltage at least twice the maximum phase-to-earth voltage. After the clearance of a short circuit or the tripping of a heavy load, a dynamic over-voltage might occur due to the inertia of governors and voltage regulators. In this case the voltage might rise above the maximum rated value and, if a circuit breaker had to operate during that time, a higher recovery voltage would appear across its terminals. If the figure of 1·5 was reduced, therefore, at least a safety margin must remain.

A developing fault generally began with a small current which turned into a larger short-circuit current through a flashover or a breakdown in the network, e.g. when switching off lines or transformers on no load. As developing faults appeared during the arcing time of the circuit breaker, the restrike might develop high shock pressures, endangering the interrupting chambers. Tests on this special point were necessary.

Mr. G. F. Peirson (Midlands Electricity Board) agreed that testing should cover both short-circuit and normal service conditions. The authors' suggestion regarding an additional proving test at 5 per cent of the short-circuit rating was worth pursuing. To prove the performance of a breaker controlling, say, a transformer feeder might require tests at even less than 5 per cent. Such tests would establish whether the arc energy at these low currents was sufficient to produce the required pressure within the arc-control device to scavenge that device and re-establish the dielectric strength sufficiently to prevent restriking.

Mr. C. H. Flurscheim (Metropolitan-Vickers) differed from the authors' view that a reduced test voltage was more permissible on an air-blast than an oil circuit breaker. Reduced voltage was not really permissible on either type, and with the present state of test plants and technique and circuit-breaker design the authors might well have suggested full-scale testing, relating the full-scale test on the interrupter to the probable voltage in the network at full breaking capacity, for which the authors' figure of 1·2 or 1·3 phase-to-neutral might be considered realistic. Two alternative requirements were needed: twice phase-to-neutral on solid networks, as in this country, and 2·5 or 2·6 times on weaker networks abroad.

Not many years ago two tests were considered sufficient to prove a circuit breaker. This had been raised to 17 before the war, and the authors now suggested 59 for a large breaker, while even 75 to 100 were not unknown. He would like to ask how much of this testing must be repeated for type tests for all the different ratings.

Mr. D. M. Cherry (Central Electricity Authority) referred to the practice in mechanical circles of doing tests at something more than the service conditions and held that 1·5 times the recovery voltage was necessary. No more than three or four phase faults clear of earth had occurred on the grid system in the last ten years, and probably none of them were at the maximum short circuit of the network, but there were other considerations to be taken into account. The arc, for instance, could easily operate for another half-cycle and introduce severe stresses.

Mr. J. S. Cliff (G.E.C.), championing super-excitation as against over-excitation, gave results showing a better performance than the authors inferred. To obtain satisfactory super-excitation, he said, a generator must be designed to take it, the essential feature being that the stator iron should be well saturated. As the stator voltage rose comparatively slowly the super-excitation could be applied before the start of short circuit, in the same way as the authors' over-excitation, but it was much more effective.

Mr. C. W. Mott (C.E.A.) doubted whether a single schedule of tests would give adequate proving for all breakers of the same rating but of different types, or for

the same breaker on different test plants where the output varied. The proving of such circuit breakers would probably continue to be the subject of discussion and agreement between the manufacturer, testing authority and the user. It appeared from the papers that there was now agreement on a constant value for r.r.r.v. at 100 per cent short-circuit rating, irrespective of the service voltage, though not on the constant value. In 1949 a paper presented to the Institution took 700 V/microsec as the limit of r.r.r.v., whereas the present authors' figure was about 1,600. The increase was due to the larger plant units used to-day and the growth of systems, and would continue. Circuit breakers purchased to-day were expected to have a life of 20 to 30 years and must be suitable for dealing with the service conditions likely to be experienced during that life. He considered, therefore, that the authors' figures for proving circuit breakers were too low.

Mr. L. C. Walshe (Kennedy & Donkin) said that in this country, with a stiff network, final separation between two sections of the grid on a fault was most unlikely. That did not apply on many foreign systems where the generating source might be 500 miles from the load centre, and a voltage reduction factor below 1·5 might be unacceptable. He had recently been in a country which had been without a supply for more than two hours owing to complete break up of the system. That would be a serious risk with long transmission lines until d.c. transmission became general.

Mr. J. M. Hawkins (English Electric Co.) mentioned that he had witnessed tests made on the h.v. network of Electricité de France and had taken part in the first line-switching tests on the 275 kV network in this country. In both cases valuable results had been obtained. He advocated the establishment of testing facilities on British networks not only for the proving of breakers but also for use in the development stage.

Mr. W. Casson (C.E.A.) asked whether the authors considered that proving tests should include a single-phase to earth fault test in which the current would be 20 to 30 per cent in excess of the three-phase rating current, and whether there would be any great difficulty in designing circuit breakers to meet these conditions, of course at no extra cost.

LETTERS TO THE EDITOR

Letters should bear the writers' names and addresses, not necessarily for publication. Responsibility cannot be accepted for the opinions expressed by correspondents.

Church Heating Installations

HEATING engineers are frequently blamed, probably with some justification, for the empty pews in our churches during the winter. Is this surprising if the Church Council is content with planning for a temperature of 48 deg F during evening service, as shown by Mr. Gaunt's thermograph record (*Electrical Review*, 11th March)?

The problem is a difficult one as, on the B.Th.U. basis, space heating of these ancient edifices by electricity is costly if it is to be effective. If funds do not permit an adequate installation for warming the building is it not better to safeguard the reputation of electric heating and concentrate the calories at leg level?

In one particular installation in which I was interested, under-pew tubular heaters were installed to boost the background heat from an inadequate coke-fired boiler system. This particular church has a floor area of 1,660 sq ft and it would have required 50 kW for adequate space heating with a 24-hour preheating period. The general comfort of the congregation has been considerably improved by installing 11 kW of under-pew heaters and one tubular heater under the west window to invert the draughts occasioned by the air cooling effect of the expanse of glass.

Loughton, Essex. A. R. LASH, M.I.E.E.

Interference Suppression

THIS is a matter of grave importance to the electrical industry with which I have been associated for over 50 years. It should be treated in the way the British Electricity Authority deals with supply and the public should not be bluffed by the B.B.C. or P.O. engineers who no doubt are expert on telephone work, etc., but know little of normal installation work which the B.E.A. do. I well remember over 50 years ago before Home Office regulations came when Mordey alternator and d.c. Brush machines of 2,500 V were in use and 1,000 kW was a big set. We coupled up a printing works with a guillotine used for chopping up half a ton of paper at a blow; of course it knocked the lighting from all around to blazes. We just had to put in a special feeder and improve the transmission, which is just what the B.B.C. and P.O. should be forced to do instead of being allowed to pass the onus on to the public. It should also be remembered that the B.S. 613 or any other code has no statutory authority.

Regent's Park, N.W.1. A. V. SUMMERS,
Chairman,
Milliwatt, Ltd.

Electrical Safety Courses

I SHOULD be grateful if you could give some publicity to the following course. At Burton Manor College for Adult Education, courses on electrical safety are regularly held. The next course, which is to be held from 22nd to 28th May, is for graduate electrical engineers and will be attended by engineers from several of the more important European countries.

A special feature is being made at this course of the effects of static electricity and means of combating it, and papers will be given on mathematical analysis of the electrostatic problems, means of combating static by radioactivity and similar techniques, and on some means of detecting static electricity by electronic devices. More general subjects will include earthing, protection, corrosion, electrical injuries and first aid, welding, and dust and explosion hazards. All these lectures will be given by acknowledged experts in the particular fields. Applications for attendance at the course should be made to the Warden, Burton Manor Residential College for Adult Education, Burton-in-Wirral, Cheshire.

There will also be a course from 27th November to 2nd December next for craft supervisors.

All these courses are organized by the Factory Department of the Ministry of Labour and National Service.

DONALD A. PICKEN,
H.M. Electrical Inspector of Factories.

INDUSTRIAL NEWS

Cable Makers' Wages

At its meeting held on 23rd March the Joint Industrial Council for the Cable Making Industry authorized its negotiating committee to put into effect any settlement reached by the committee in regard to the applications of the trade unions for increases in wages and in improvements in the payment by results formula. The following decisions have been reached by the negotiating committee:—

(1) That the timeworkers' rates of wages, as set out in Schedule II of the J.I.C. Agreements, shall be increased by 2½d an hour or 9s 2d a week of 44 hours in respect of adult males, and by 2d an hour or 7s 4d a week of 44 hours in respect of adult females. (2) That the timeworkers' rates of wages for those below adult age shall be increased as follows: Males, age 15, 1d; age 16, 1¼d; age 17, 1½d; age 18, 1¾d; age 19, 2d; age 20, 2¼d. Females, age 15, 1d; age 16, 1¼d; age 17, 1½d. (3) That the foregoing advances shall apply to all workers whether remunerated on time rates, on payment by results, or otherwise. (4) That the formula relating to payment by results systems agreed by the Council on 31st January, 1951, shall be amended by the insertion of 15 per cent in place of 10 per cent. (5) That the fall back rate for payment by results workers shall be the appropriate timeworkers' rate. (6) That payment by results workers shall not receive enhanced bonus earnings as a consequence of the foregoing advances, apart from any amendments which may be necessary to payment by results systems applied to direct production workers in order to conform to the formula of 31st January, 1951, as amended. (7) That the foregoing increases in wages and alteration of the payment by results formula shall become effective as from the begining of the first full pay period following 23rd March last.

Technical State Scholarships

Details of the Technical State Scholarships to be awarded this year are announced in a Ministry of Education memorandum to local education authorities, technical colleges and further education establishments. Most of the scholarships will be offered to students from technical colleges and other establishments of further education who have obtained an ordinary national certificate or equivalent qualification, and will enable them to pursue full-time honours degree courses or courses of equivalent standard at universities, university colleges or establishments for further education. Candidates must have been in full-time or part-time attendance at a further education establishment for not less than two years immediately preceding 1st August of the year in which the award is made. The Minister may allow an exception to be made to this condition in special circumstances, such as National Service. A limited number of awards may also be made to enable suitable candidates who by part-time work have obtained an initial qualification of university first degree or higher national certificate standard to attend approved post-graduate courses of study or research in applied science or technology. The awards will be available for a minimum of one year and a maximum of three years. Candidates for these awards must give full particulars of the study or research which they intend to undertake and must be recommended not only by the further education establishment at which they obtained their initial qualification but also by the establishment at which they propose to take a post-graduate course.

Equipment for Lisbon Underground

Contracts to the value of some £200,000 have been placed with the General Electric Co., Ltd., by the Metropolitano de Lisboa, S.A.R.L. (Lisbon Metropolitano Railway), for power supply, ventilating and pumping equipment for the Lisbon Metropolitano, the first underground railway in Portugal. The contracts were gained in the face of intense Continental competition, and are the only ones awarded to a British manufacturer in connection with this scheme.

The Metropolitano will be a 4ft 8½in gauge railway operating at 750 V d.c., and will be constructed mainly on the cut-and-cover system, although short sections will require tunnelling. Stage 1 of the project, for which the present contracts have been placed, involves the line from Restauradores to Entre Campos, and a branch from Rotunda to Seta Rios with a spur to the workshops, a total of some 4·3 route miles. The planned total mileage of the system so far is 11·97 route miles, and extensions which would bring the total to 25·7 route miles are in view.

At the main substation, where power is taken at present from the supply undertaking at 10 kV, the G.E.C. is supplying a 7-panel 10 kV oil circuit breaker swtichboard, a 1,000 kVA, 10 kV/3 kV transformer, and an 11-panel 3 kV switchboard for controlling supplies to auxiliary services. Standby auxiliary power will be provided by a 1,000 h.p. diesel-alternator set comprising a 1,000 h.p. Ruston/Paxman 12YLX engine coupled to a G.E.C. alternator. At the traction substation for the first section of the line there will be two 750 kW pumpless air-cooled steel tank rectifier equipments with transformers. The complete a.c. and d.c. switchgear installation at the substation is also being supplied by the G.E.C. Pirelli-General paper-insulated, steel-wire armoured h.v. cables will be provided for the 10 kV feeders to the main substation and through the tunnel to the traction substation; and 3 kV cables for auxiliary services throughout the line. The contract includes lighting and ventilation at the main substation, and ventilation at the traction substation.

The G.E.C. will also be responsible for the supply and erection complete of the ventilation system for the tunnels and the eleven stations in the first stage of the scheme, and for the pumping system. Woods of Colchester, Ltd., a G.E.C. subsidiary, will supply double-duty axial flow fans driven by two-speed squirrel cage motors for installation at seven ventilation points. Barrett & Wright, Ltd., of London, will be the main sub-contractor to the G.E.C. for the equipment at 13 pumping stations, where the immersible centrifugal pumps will be supplied by Lee Howl & Co., Ltd., Tipton, Staffs, and the driving motors and control switchgear by the G.E.C.

Cambridge Fellowships

It is announced that two fellowships at Cambridge have been offered under seven-year covenants to provide salaries of between £900 and £1,400 a year. One fellowship, in physics, tenable at the Cavendish Laboratory, is in the name of the Metropolitan-Vickers Electrical Co. The other, in the name of the British Thomson-Houston Co., is in engineering and tenable in the Department of Engineering.

Post-Graduate Bursaries

We are informed that the Metropolitan-Vickers Electrical Co., Ltd., has endowed four post-graduate bursaries in electrical and mechanical engineering, each of the value of £400 per annum, in the University of Manchester; two of these bursaries will normally be tenable in the Faculty of Technology of the University at the Manchester College of Technology. The company has also endowed three similar bursaries tenable in the Mechanical and Electrical Engineering Departments at the Imperial College of Science and Technology, London.

Telecommunications Training

A new training school is due to be opened to-day (Friday) by Cable & Wireless, Ltd., at Electra House, Hong Kong, centre of its Far East

telecommunications network. It will train locally recruited staff selected from the company's branches in the Far East area. Students will spend eighteen months studying the technical aspects of submarine cable telegraphy. On completing the training course successfully they will return to their branches and take up cable watch-keeping duties. Mr. A. F. Sutcliffe, of Lymington, Hants, will be instructor-in-charge of the new school.

Railway Freight Scheme

The British Transport Commission has issued the draft of its scheme for new maximum charges for merchandise. This will be submitted to the Transport Tribunal for approval. Its object is to give the railways greater freedom to compete with private enterprise road transport.

Physical Society Spring Meeting

The opening of a large lecture theatre outside the security fence at the Atomic Energy Research Establishment, Harwell, has made it possible for Harwell to invite the Physical Society to hold a meeting there, on nuclear energy levels and neutron physics, this week, commencing yesterday (Thursday). About 80 members of the Harwell staff and 120 visitors are expected; papers are being presented from the laboratories at Harwell, Oxford, Cambridge and London. The conference will end with a visit to the Harwell laboratories on 2nd April.

Sales Conference

The Bill Switchgear, Ltd., annual sales conference was held this year in Birmingham on 23rd February. The meeting, under the chairmanship of the sales manager, Mr. H. G. Palfreman, was told that, in spite of current production difficulties, the company had achieved a record turnover for the year, the total net value of sales having considerably exceeded that in any previous year. The erection of a further factory in the Birmingham area would give facilities for a substantial increase of turnover by 1956. The policy of distributing the company's products through the electrical wholesale trade would be continued, and the area branch offices would be used to a greater extent in future to provide an efficient service in the distribution of products. Mr. R. W. Bill, chairman of the company, and Mr. R. A. Bill, managing director, joined the staff for lunch.

Electricity Employees' Suggestions

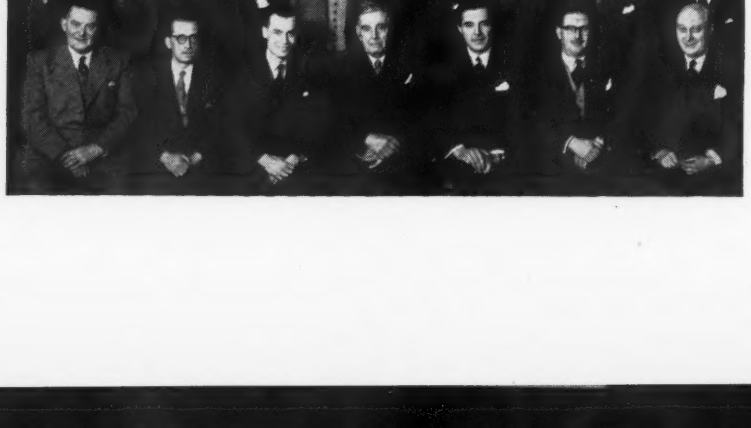
We have received from the National Joint Advisory Council for the Electricity Supply Industry, Winsley Street, London, W.1, the first issue of a "Suggestions Review." In this illustrated details are given of ideas put forward by employees of the Central Electricity Authority and the Electricity Boards for improving efficiency of operation in many directions. They include suggestions for altering and adapting existing equipment and also new devices. In most cases the names, portraits and brief details of the suggestions are given and the amount of the award for each idea is also stated. Some of the suggestions adopted are of wider application.

South African Industry

Mr. J. Oldham, chairman and joint managing director of Oldham & Son, Ltd., has recently returned from a three months' visit to South Africa, and at a meeting in London last week he gave some impressions of South African industrial development. He said that South Africa was in the grip of economic developments of great power and he referred to the South African Prime Minister's recent speech made to launch the "Buy South African" campaign, which indicated the change which had taken place in the Union's economy during the last few years.

Mr. Oldham said that secondary industry had become a dynamic factor in the country's social and economic structure and now contributed about 23 per cent of the national income as against 9 per cent for gold mining, or including diamond, coal and metal mining, about 12 per cent. In looking at the political and industrial future of South Africa consideration should be given to developments which the future might witness concerning South Africa's relationships with other territories in Southern and Central Africa. Already South Africa had valuable trading relations with other African territories. Of increasing importance was the expanding volume and strength of South African industry as a source of supply of manufactured goods. Mr. Oldham said that he concluded his fifth visit to the Union confident in the future of her industrial and commercial development and confident of the future of British enterprises which were now spreading themselves throughout the continent of Africa.

Executives of Bill Switchgear, Ltd., at the recent sales conference in Birmingham. Seated in the centre is Mr. R. W. Bill (chairman of the company), with Mr. R. A. Bill (managing director) on his left and Mr. H. G. Palfreman (sales manager) on his right



Babcock & Wilcox Fusion

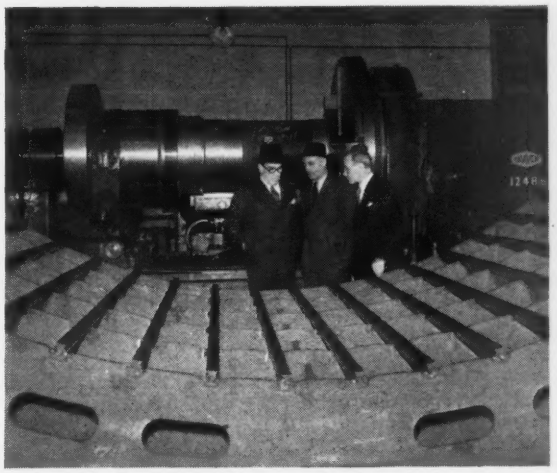
Babcock & Wilcox, Ltd., announce the fusion of the trading activities of two of their subsidiary companies, Spencer-Bonecourt, Ltd., and the Clarkson Thimble Tube Boiler Co., Ltd. The name of the former company has been changed to Spencer-Bonecourt-Clarkson, Ltd., and it has assumed responsibility for all new business in Spencer-Bonecourt waste heat boilers, the Clarkson marine and industrial waste heat, oil, and gas-fired boilers and the new "Autoheat" oil-fired domestic boilers. The chairman of the company is Captain (E) W. Gregson, R.N.R., formerly chairman of Spencer-Bonecourt, Ltd. Mr. S. W. Spurr, managing director of the Clarkson Co., becomes managing director, while Mr. A. E. Watkins becomes deputy managing director of Spencer-Bonecourt-Clarkson, Ltd. The secretary is Mr. J. H. Worlledge. The offices remain at 14, Fetter Lane, London, E.C.4.

Cathedral Sound Equipment

The installation of a complete sound reproduction unit in Blackburn Cathedral has recently been completed by Philips Electrical, Ltd. Work on the extension of the cathedral has been proceeding since 1937. The new construction provides for much larger congregations than before and it was decided by the Provost and Diocesan Committee that a system of sound amplification would be necessary.

The installation was carried out by Philips engineers in conjunction with John Walsh (Electreliance), Ltd., Blackburn, who were responsible for the wiring. This called for special measures as it was essential that all cables should be concealed and that nothing should mar the beauty of the building. This concealment was achieved by drilling holes in the stone floor, so that the wiring between amplifier and microphones could be laid beneath it. Overhead wiring to the loudspeakers was laid above the ceiling in the roof void.

The sixteen speakers are of a special design embodying a diffuser type unit and are finished in old gold. They have been incorporated in the lighting



Left: Mr. G. E. C. Attwood (second from left) explains some of the equipment at the power station to Mrs. Eames (left) and Mrs. Gregg, seen with the Lord Mayor during a Birmingham civic visit to the M.E.B. headquarters and Stourport power station. Right: Mr. A. C. Main, director of manufacture (centre) and Mr. J. S. Wright, superintendent, Plant Department (right) with the Brazilian Ambassador in the large electrical machine department of the Trafford Park Works of the Metropolitan-Vickers Electrical Co., Ltd.

suspensions, just above the lighting fittings. Four ribbon microphones have been supplied. One of these is mounted on a floor stand by the lectern and two, on desk stands, are portable. The fourth microphone is mounted permanently on an overhead suspension on the pulpit. The amplifier is a Philips 20 W EL6400; this is associated with a four-way electronic mixer, giving independent control to each of the four microphone positions.

Civic Visit to M.E.B.

A Birmingham civic party including the Lord Mayor and Lady Mayoress of Birmingham (Ald. and Mrs. J. R. Balmer) on 23rd March paid a visit to the headquarters of the Midlands Electricity Board at Mucklow Hill, Halesowen, and to Stourport generating station, Worcestershire. The party included the Town Clerk of Birmingham (Mr. J. F. Gregg) and Mrs. Gregg, and the city treasurer (Mr. J. P. Eames) and Mrs. Eames. The visitors were received by the chairman of the Board, Mr. W. S. Lewis, and the deputy chairman, Mr. D. P. Sayers, and at Stourport by the Midlands divisional controller, C.E.A. (Mr. J. L. Batley), the divisional generation engineer (operations) (Mr. L. A. E. Fosbrook) and the station superintendent (Mr. G. E. C. Attwood).

Brazilian Ambassador Visits Trafford Park

His Excellency Sr. Samuel de Souza-Leao Gracie, the Brazilian Ambassador in London, accompanied by Sr. Affonso Rodrigues Palmeiro, Counsellor at the Brazilian Embassy, and Sr. Octavio Augusto Dias Carneiro, First Secretary at the Embassy, visited the Trafford Park Works of the Metropolitan-Vickers Electrical Co., Ltd., on 22nd March. During an extensive tour of the works the party saw a wide range of manufacture in progress. This included traction control equipment for the Central Railway of Brazil, for which the company has a contract for 200 complete railway coaches and 100 sets of electrical equipment.

Industrial Safety

The Ministry of Labour is taking special steps to ensure the maintenance of industrial health and safety and one of the steps taken has been the complete reorganization and renaming of the industrial museum at 97, Horseferry Road, London, S.W.1, which Sir Walter Monckton, Minister of Labour and National Service, formally renamed the Industrial Health and Safety Centre on Tuesday last week. The Centre is a permanent exhibition of methods, arrangements and appliances for promoting safety, health and welfare in industry. It is the only one of its kind in the country and contains an up-to-date collection of exhibits, many of which are lent by manufacturers and can be demonstrated in use.

The display occupies three floors and includes a section illustrating the principles of good lighting and emphasizing the relationship between lighting and colour. Nearby is a room devoted to the heating of work places. The electricity section shows the different types of switches and fuse boxes and special lighting fittings for dusty and dangerous atmospheres. Methods of testing both on high and low voltage, types of wiring, etc., are also demonstrated.

Other sections deal with interlocking and relay switches and door fastenings, mechanical handling, the use of photo-electric cells, lifting tackle and appliances, and hand tools, industrial diseases and canteen equipment.

Service Centre Competition

The South Western Electricity Board's service centre display competition, which attracted about 90 entries from all over the West Country, has been won by the Taunton centre, whose winning team will be presented with the Area challenge cup. This success means that the cup will be retained in the Taunton Sub-Area for a further year, the previous winner having been the Tiverton service centre which comes within the Board's Taunton Sub-Area. Second prize in the competition has been awarded to Patchway service centre (Bristol Sub-Area) and third place was won by Torquay (Devon Sub-Area). The service centres at Nailsea and Whiteladies Road (Bristol), Barnstaple (Taunton Sub-Area), Sidmouth (Devon) and Saltash (Cornwall) were commended for their all-round work in both interior showroom and window displays, while the Plymouth service centre team were commended for their window display. The judges were Mr. A. J. Symes and Mrs. Frank Forrest.

Atomic Pile Model

The United Kingdom Atomic Energy Authority has lent to the Science Museum, South Kensington, a large working model showing the "B.E.P.O." atomic pile, the larger of the two pioneer atomic piles set up at Harwell. The model goes through a complete cycle of operations in five minutes and shows the working of the control and shut-down rods which govern the heat output of the pile, and the movement of the hoist for loading uranium rods into the pile.

New Homes from Old

A new E.D.A. 8-page illustrated booklet entitled, "Electricity a Power of Good for Improvements and Conversions," is of particular interest to local housing authorities and officials, architects, builders and owners of old property which may be improved or converted as a result of the Housing Repairs and Rents Act. It is pointed out that there are several million

houses, built from 50 to 80 years ago, which are structurally sound but without the amenities now considered essential. These can be brought right up to date and made comfortable, labour-saving and economical to run—with the help of electricity. Larger houses can be converted into all-electric flats, without the difficulties of fuel storage and ash disposal for the upper floors, and the need to plan bathrooms and kitchens round the existing chimney stacks, which are seldom found in convenient places for the new rooms. Sections of the booklet are devoted respectively to electric heating, cooking, water heating and the home laundry, while two pages of plans show examples of typical conversions. Copies of this new booklet (E.D.A. 1768) are obtainable from the Electrical Development Association at 2, Savoy Hill, London, W.C.2, or from electricity service centres, free of charge.

Works Communication Installations

Installations of "Clearcall" communication equipment have recently been completed by the British Thomson-Houston Co., Ltd., for a variety of industries. In many instances carrier-frequency techniques to provide speech-communication over

B.T.H. "Clearcall" out-station in a steel works

power lines have been employed. A great advantage of the system is that communication can readily be established between a fixed control point on the ground and moving plant such as electrically operated overhead cranes and transporters.

At the Scunthorpe works of John Lysaght the carrier frequency system has been injected into the existing 440 V supply lines to seven different points in the coal blending plant, thus saving over £3,000 in cost of cable and its maintenance. At the Abbey Works of the Steel Company of Wales, communication is provided between ground and moving cranes. In the melting shop all cranes take their power from the two substations; the power supply is 500 V d.c., the centre point being lightly tied to earth. There are three crane tracks, but only one-way communication from ground to crane is required. The scheme is flexible because of the large number of speaking-points on the ground. "Clearcall" communication has also been established for hazardous area working between the ground control point and the top of a blast furnace gas-holder.

Intercommunication systems of this kind at the works of the Rugby Portland Cement Co., Ltd., and the Lafarge Aluminous Cement Co., Ltd., expedite the handling of various grades and quantities of cement.

Machine Tool Trades Dinner

Mr. R. D. G. Ryder, president, took the chair at the annual dinner of the Machine Tool Trades Association at Grosvenor House, London, W.1, on 23rd March, and proposed the health of the guests. Viscount Chandos, chairman of Associated Electrical Industries, Ltd., responded to the toast. Sir Rowland Smith, chairman of the Ford Motor Co., Ltd., proposed the toast of the Association and the response was by Mr. J. B. S. Gabriel, past-president. About 1,200 members and guests were present.

E.C.A. London Branch

The annual dinner of the London Branch of the Electrical Contractors' Association will be held on 4th November at Grosvenor House, Park Lane, London, W.

Course for Schoolboys

During the forthcoming Easter vacation a group of twenty-five public and grammar schoolboys will gain first-hand experience of the mechanical and electrical manufacturing industry, when they attend a short course at the Trafford Park Works of Metropolitan-Vickers Electrical Co., Ltd. The boys will be drawn from a number of well-known schools in the country and the scheme arises from suggestions made at the conference of headmasters and senior science masters held at the works in 1954. The course at the Trafford Park Works will provide basic instruction in the use of hand tools and machine tools and other fundamental engineering practices. This will be co-ordinated with a programme of tours, talks and films and there will be a full working day in a selected manufacturing department under normal working conditions. Apprentice "old boys" from the schools represented will act as hosts for a programme of social and athletic events.

Trade Announcements

Power System Computors, Ltd., Vine Lane, Newcastle-upon-Tyne, informs us that it has now commenced the design and manufacture of all types of computors for the analysis of power systems and machines. The parent company (Joyce, Loebl & Co., Ltd.) was engaged on the development of a.c. network analysers for over two years and it was felt that the experience could best be utilized by the establishment of a new company entirely devoted to this work.

Following on the recent change in management and reorganization of staff, the **Electran Coil Winding & Transformer Co., Ltd.,** announces a reduction in price of radio transformers and chokes, etc. A new production programme has now been laid out and the company is in a position to offer deliveries ex stock.

Change of Address

The Association of Public Lighting Engineers has moved to 17, Victoria Street, Westminster, London, S.W.1 (telephone: Abbey 4281).

TRADE MARK APPLICATIONS

APPLICATIONS have been made for the registration of the following trade marks. Objections may be entered up to 9th April:—

DIEHL. No. B735,465, Class 7. Electric motors (not for land vehicles), generators, electrically-driven drills and bench grinders (machines).—Diehl Manufacturing Co., New York, U.S.A Address for service, c/o Cruickshank & Fairweather, 29, St. Vincent Place, Glasgow, C.1.

UDYLITE. No. 725,931, Class 9. Electrical apparatus for the phosphating and electroplating of metals, and parts.—Udylite Corporation, Detroit, U.S.A. Address for service, c/o J. A. Kemp & Co., 329, High Holborn, London, W.C.1.

TORAN. No 735,340, Class 9. Electronic, radio and television apparatus.—Electrical Products Export International, Ltd., 105-109, Judd Street, London, W.C.1.

SILVER EXIDE. No. 736,386, Class 9. Lead-acid electric accumulators.—Chloride Electrical Storage Co., Ltd., Exide Works, Clifton Junction, near Manchester.

ELLIOTAUTOMATION. No. 736,408. ELLIAUTOMATION. No. 736,409, Class 9. Electrical and mechanical measuring, testing, indicating, recording and control instruments and apparatus; temperature measuring apparatus, electrical resistance thermometers, temperature indicators and recorders, humidity measuring and recording apparatus, pressure gauges; level indicators and alarms, boiler control apparatus; transmission systems for remote indication, integration, recording and control of power, liquids and gas pressures; telegraph instruments and apparatus; and wind-speed measuring and indicating instruments and apparatus. — Elliott Brothers (London), Ltd., Century Works, Lewisham, London, S.E.13.

SIMPLEX PROTECTOR. No. 736,620, Class 9. Electric switches, fitted electric switchboards, electric cut-outs, fitted fuseboards and casings for electric fuses.—Simplex Electric Co., Ltd., Broadwell, Oldbury, near Birmingham.

TORVAC. No. 736,661, Class 9. Electronic discharge tubes.—Tottenham Radio Valve Co., Ltd., West Road, Tottenham, London, N.17.

B. & P. (design). No. 736,758, Class 9. Electrical measuring instruments.—Beckett & Parker, Ltd., 157-159, Summer Lane, Birmingham, 9.

GENERATION AND DEVELOPMENT

Ash Disposal at Portishead

A site of 96 acres at Portbury Wharf is at present being used by the Central Electricity Authority for the disposal of ash from Portishead generating station. Of this site some 46 acres has now been, or is being, covered with top soil and seeded, and the C.E.A. has made application to purchase a further 61 acres. At a recent inquiry Mr. A. C. Thirtle, divisional controller, said that the 170,000 tons of ash now being disposed of each year from the Portishead "A" station would probably increase to 520,000 tons by 1960 on completion of the "B" station.

It was submitted that the land was at present of poor agricultural value and that after the top soil had been removed, about 10ft of ash spread over it and the top soil returned and seeded, the land would be improved. The planning authority and Portishead U.D.C. were agreeable but the present owners and tenants raised objection on the grounds of financial loss and fear of dust injury to cattle and sheep. An alternative site of 650 acres in the Gordano Valley was suggested. For the C.E.A. it was said that the transport cost would be increased by 50 per cent as this site was over three miles from the station and the route to it would be through the High Street and along the narrow Clevedon Road. The U.D.C. was opposed to any extra industrial traffic using the High Street.

Southern Area Topics

The opening of showrooms on Saturday afternoons was again fully discussed at the last meeting of the Southern Electricity Consultative Council held at Winchester on 15th March, with Group Captain J. C. M. Hay in the chair. Opinions were expressed that more consumers would be adversely affected than would benefit by Saturday afternoon opening of showrooms and that the demand did not appear to be strong enough to justify causing the difficulties which were expected to arise. Figures for January were produced to show that a considerable number of consumers visited the showrooms in question on Wednesday afternoons. In view of these considerations it was agreed to test again the feeling of the Council and a motion to rescind the previous request to the Board to carry out experimental Saturday afternoon opening was carried by nine votes to seven.

The Council considered the Board's reply setting out reasons why it felt unable to accede to the Council's request for the application of the domestic tariff to certain premises such as old people's and children's homes. It was decided to pursue the matter further.

Some dissatisfaction having arisen in one of the Districts concerning the assessment as kitchens of certain lean-to sheds, the Council asked the Board for its definition of a kitchen for the purposes of assessment under the domestic tariff. The Board replied that its test of eligibility for assessment as a kitchen was whether or not the room was used for the preparation of food. When the cooker was placed in a "scullery" or "lean-to," the room housing the cooker was assessed as a kitchen only if food was prepared as well as cooked in the room.

The members of the Council had before them a summary of the practice of other Boards in the matter of rural electrification. They also noted the Southern Board's expectation that 85 per cent of farms and associated premises would be connected by 1961, and that its representatives were visiting Ireland from 28th March to 1st April to study low voltage overhead construction there. It was agreed to defer further consideration of the matter pending the results of this study.

Additional Tummel-Garry Station

Tummel-Garry Project (Amendments), Constructional Scheme No. 2A, published last week by the North of Scotland Hydro-Electric Board, covers the construction of a small power station in Glen Errochty in Perthshire which will add 1¼ million kWh yearly to the estimated annual production of 300 million kWh of the Tummel-Garry scheme. The Board is required to provide compensation water from the Errochty dam to give a minimum flow in the River Errochty and it is proposed to use this water to produce power. A station to be built just below the falls on the Errochty Water near Trinafour will have a capacity of 550 kW.

New Belfast Power Station

It was agreed at a special meeting of the Belfast Corporation Electricity Committee last week that the new Harbour power station should be officially commissioned early in May. Work commenced on the station in October, 1951. The first set has been in operation since last September and the second went into service a fortnight ago. It is hoped that the station will be completed in 1957.

Rural Development Charges

St. Thomas Rural District Council recently had before it another report concerning the electricity supply to Clyst St. Lawrence and Clyst Hydon, which had been referred back to the Committee. It had previously been recommended that where a rural development charge was paid to the Electricity Board the tenants should be charged an additional rent of 2s 4d a week for the seven years during which the development charge was payable. The chairman said that, on reflection, it seemed a little unjust that tenants in the outlying parishes should have to pay higher rents than those in parishes where all services were available. It was therefore recommended that, where there were rural development charges, the lump sum should be paid by the Council.

Lower Industrial Charges

Industrial consumers in the South Eastern Area will pay slightly less for their electricity as a result of the Board's decision to pass on the benefit of the reduction of the bulk supply coal clause adjustment factor, as from 1st April. With the price of coal for 1955-56 provisionally fixed at 80s 9d a ton the adjustment rate will be about 13s 6d for each 1,000 kWh as compared with the previous rate of 14s 6d.

Douglas "All-in" Tariff

As from 1st July all domestic consumers in the Douglas (I.O.M.) Corporation's area, including those supplied through prepayment meters, are to be placed on an "all-in" tariff. The quarterly fixed charge will be 10d in the £ of the rateable value and the running charge 1¼d/kWh for the first 250 kWh a quarter and 1d/kWh thereafter. Seasonal private hotels and boarding houses are also to be placed on the "all-in" tariff system.

Lignite Fuel in Madras

It is reported by *Indian Trade and Industry* that four schemes for the exploitation of lignite deposits at Neyveli in the South Arcot district of Madras State have been recommended to the Government of India by Powell Duffryn Technical Services, Ltd. All four schemes include the generation of electricity combined with the production of ammonium sulphate, briquettes, etc. The annual output of lignite projected under the various schemes ranges from 1,070,000 to 6,268,000 tons and the capacity of the associated power station from 200 to 263 MW. The station would feed into the Madras grid.

N.S.W. Bulk Supply Charges Criticized

A claim that the New South Wales Electricity Commission had overcharged for bulk supplies by £5,345,158 in the last financial year was made when a deputation from ten suburban councils met the Minister for Local Government recently. Councillor F. Collings, of Hornsby, said that the Commission had tried to make out that its surplus for the year ended 30th June, 1954, was only £446,261. It had "buried" the fact that it had placed another £4,899,897 in reserves. This combined profit from the year's operations amounted to a 25 per cent "dividend" on operating costs.

Councillor Collings said that the figures more than justified allegations by suburban electricity undertakings that the Commission was charging extortionate prices for bulk electricity.

Cheaper Electricity in Sydney

Sydney County Council, New South Wales, has unanimously decided to devote its profit of £859,000 on last year's operations to the reduction of electricity charges. The Council had already cut charges by £1,300,000 since last June.

Mauritius Power Project

Work started recently on a new hydro-electric power project at Eau Bleue, Mauritius. Situated in the midland region on the island, where the average annual rainfall is 160in, the new station will have a dam which will enclose a reservoir 9·6 million sq ft and with a capacity of 210 million cu ft. The dam will be 800 yd long and its greatest height will be 63ft. The plant is expected to produce 5 million kWh a year and the cost of the scheme will be Rs 3,400,000 (£255,000). A supplementary scheme, entailing the diversion of additional waters into the reservoir, which would increase the production of electricity to 8 million kWh, may be undertaken later at a total cost of Rs 1,500,000 (£112,500). The new hydro-electric plant is expected to come into service at the end of 1957.

Quebec Scheme Speeded Up

The date for the completion of the full 1,200,000 h.p. development of the Quebec Hydro-Electric Commission's $225 million Bersimis River generating plant has been advanced by two years to 1959. This follows forecasts of a substantial increase in the power demand. The first two 150,000 h.p. generators will be installed by the end of 1956, followed by two more in each of the years 1957, 1958 and 1959. This is not the first time that the Commission has accelerated its expansion plan to meet a sharp increase in power demand. It was estimated originally that the last generator in the Beauharnois No. 2 power station would not be needed until 1958 but it was, in fact, installed in 1953.

Shawinigan Company's Report

Reviewing the operations of the Shawinigan Water & Power Company, the president, Mr. J. A. Fuller, says that 1954 was a record year as regards gross revenue and peak load, and the company's financial return on its large investment is showing improvement. Net earnings from all sources available for dividends on the common shares totalled $2·84 per share against $2·26 in 1953. Improved prices for primary power are gradually being realized. Almost 10,000 new customers were connected to the company's lines. Water conditions were particularly good in the last four months of the year. The company became the sole owner of the St. Maurice Power Corporation and its 166 MW generating station at La Tuque, P.Q. Further progress was made with work preparatory to the installation of three additional generating units, one each at Rapide Blanc, Trenche, and La Tuque generating stations. These will be in operation in the latter part of 1955 and will add about 118 MW to the system generating capacity. Work is proceeding on the new facilities required to receive power from the Quebec Hydro-Electric Commission's Bersimis development late in 1956.

Japanese Power Plans

The Electric Power Development Company of Japan is seeking funds totalling approximately £32 million for development work in the current financial year. The proposals include schemes on the Kumano River which would provide an additional capacity of 200 MW in five years.

Cape Town Power Stations

Increased efficiency at Cape Town's power stations saved the city £40,000 during the last year, said the Mayor in his annual review of the City Council's activities. The stations operated at higher efficiency than ever before, namely 24·8 per cent.

To prepare the 100-acre site of Cape Town's proposed new power station west of Langa will cost about £276,500, according to a report by the city engineer. The suggested site adjoins the sewage disposal works at Athlone. Reasons for the selection of the Athlone site include the fact that the sewage effluent could be used for a system of cooling towers.

Higher Austrian Output

Last year Austria's hydro-electric power plants produced 6,006 million kWh against 5,290 million kWh in 1953. Together with the 1,712 million kWh produced by thermal plants, total output amounted to 7,718 million kWh, 12 per cent more than in 1953.

Penang Extensions

In his report covering the year 1953 Mr. S. Mortimer, municipal electrical engineer and transport manager of George Town, Penang, says that 33·3 million kWh was sold, 9 per cent more than in the previous year and a record for the Department. A second 6,000 kW Brush turbo-alternator was commissioned during the year and site investigations were carried out for a new power station on Penang island.

Power for Chile

The installation of Mirrlees-Brush diesel generating sets has brought several new industries to the Chilean port of Arica. The town is situated at the entrance to the valleys of Yuta and Azapa and is the transit port for Bolivia and the Peruvian community of Tacna. Until recently Arica suffered from a power shortage. The Chilean State Railways decided to remedy this by inviting tenders for three diesel electric generating sets of 1,000 kW each at 6,600 V, 50 c/s.

The contract for three diesel generating sets went to Mirrlees, Bickerton & Day, Ltd., despite severe competition from the Continent and the United States. The three sets are now in service. The prime movers are Mirrlees type KS8 supercharged, 4-stroke vertical heavy oil engines each developing 1,600 b.h.p. (1,425 b.h.p. at site) at 428 r.p.m. Each engine is coupled to a 1,000 kW, 6,600 V, 3-phase, 50 c/s alternator manufactured by the Brush Electrical Engineering Co., Ltd. Each alternator is controlled by 6,600 V switchgear, also made by Brush. Arica's former distribution system was d.c. 2-wire 220 V carried on wooden poles. This system is now in the course of being changed over to a 3-phase h.v. and l.v. distribution. There is a 6·6 ring main feeding into four substations.

The town has been divided for supply purposes into four independent districts. Each district is supplied with electricity from a 315 kVA transformer having voltage ratio of 6,600/380/220 V. The substation is of simple design, the transformer being connected by fuse switches to the overhead h.v. ring main and on the l.v. side through Brush oil circuit breakers. The system is so connected that in the event of a transformer failure, supply from one of the neighbouring substations can be interconnected on to the l.v. side at 380 V.

Electrified N.S.W. Railways

The Premier of New South Wales, Mr. J. J. Cahill, officially opened the new electric train service from Parramatta to Blacktown on 28th February. The new line, which is seven miles long, is the first completed stage of electrification of the main western line from Sydney to Lithgow. It is expected that the section from Blacktown to Penrith will be electrified by next September and the fully electrified line should reach Lithgow by the middle of 1957.

The Railways Department has ordered 40 electric locomotives and 160 passenger cars for service on the line. The 160 passenger cars will be formed into eight-car trains. Half of them will be used between Sydney and Penrith and the other half between Sydney and Lithgow.

Factory Equipment Exhibition

THE third National Factory Exhibition is being held this week by the *Factory Manager* and the *Factory Equipment News* at Earls Court, London. It occupies nearly seven times the floor area of the first exhibition held at the Royal Horticultural Society's Hall, Westminster, only two years ago, and among the many exhibits there is a wide range of electrical apparatus.

With the title, " Focus on Effort," the stand of the British Electrical Development Association demonstrates that electrical aids to productivity make a great contribution to the reduction of human effort in industry. The economy of movement provided by electrical methods compared with hand operation is shown visually by interlacing wires on the lines of motion study diagrams, in the case of three typical industrial operations. Another section of the stand stresses the importance of lighting.

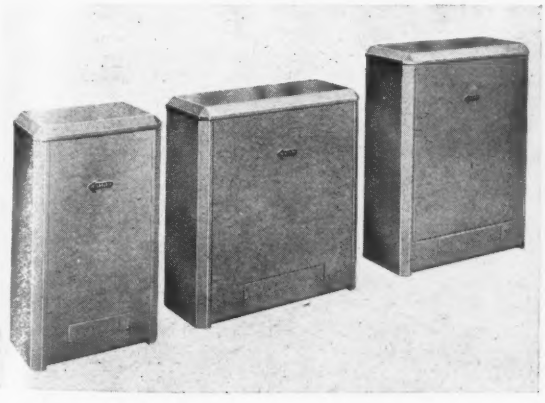
Complete schemes for factory space heating, factory lighting and canteen kitchen equipment are undertaken by the General Electric Co., Ltd. On the heating side the company's " Nightstor " thermal storage heaters are shown in three sizes, 1·5 kW " Nightstor," 1 kW " Minor " and 2·25 kW " Major." The range of unit heaters is represented by a 3 kW wall-mounted heater with its associated control unit, and a heavy duty 5 kW heater designed for larger buildings. Tubular heaters, including a flameproof unit, are shown together with two 22 kW duct heaters. G.E.C. industrial catering equipment varies in size from the 7 cu ft double oven range capable of cooking for 120 persons, to the 12in grill toaster which will take four to six chops or slices of toast at a time.

One of the new products shown by Woods of Colchester, Ltd., is the absorption-type silencer for " Aerofoil " fans, consisting of a cylindrical unit without splitters or baffles which substantially reduces the sound emitted by the fan.

The British Thomson-Houston Co., Ltd., is showing electronic equipment, laboratory measuring instruments, f.h.p. motors, industrial motors and control gear, the new magnetic/optical 16 mm sound film projector, and " Mazda " lamps and lighting equipment. Many of the exhibits are in the form of demonstrations. Of special interest for factory laboratories is a gaussmeter which provides a simple and convenient means of measuring field strengths up to 25,000 gauss. A portable frequency meter is also shown.

Among a display of fuel economy instruments by Kelvin & Hughes (Industrial), Ltd., is a boilerhouse instrument panel layout designed to promote maximum fuel efficiency. Included in the panel are draught gauges, the " Econometer," an instrument which provides in the simplest form the information necessary for maximum fuel efficiency conditions to be maintained, an electronic temperature controller, a temperature indicator, a circular chart recorder and a recorder for gas analysis and temperature measurement.

The new range of G.E.C. " Nightstor " heaters



Conveyancer E3-20 with " Skid-Stac " attachment

By using the " Isodrum " heater (Isopad, Ltd.) for the removal of remnants of solidified material from apparently empty drums, a substantial amount of material can be recovered. The company also display a wide range of electric surface heaters in the form of " Isovalves " and " Isotapes."

Mechanical handling equipment is well represented and the main exhibit of Conveyancer Fork Trucks, Ltd., is the new production model E3-20, a battery-electric fork truck of 3,000 lb capacity at 20in load centre. This is demonstrated in conjunction with the latest fork truck attachment, the " Skid-Stac," which dispenses with the need for pallets.

Among vacuum cleaning equipment is a range of Tellus suction cleaners catering for all industrial requirements, including model F120 which incorporates a fixed floor nozzle for the cleaning of large areas. Several types of New Welbeck industrial suction cleaners are on view and the latest model the " Bak-Vac," has been produced to facilitate cleaning of high and usually inaccessible places.

The numerous displays of private telephone equipment, telephone amplifiers, staff locators, etc., emphasize the importance of communications in offices and factories. Among the exhibitors are Communication Systems, Ltd., Fonadek (Branson), Ltd., and Sterdy Telephones, Ltd. The last mentioned company also show electric door locks and luminous indicators. Time recorders are being shown by G. H. Gledhill & Sons, Ltd., I.B.M. United Kingdom, Ltd., National Time Recorder Co., Ltd., and Blick Time Recorders, Ltd.

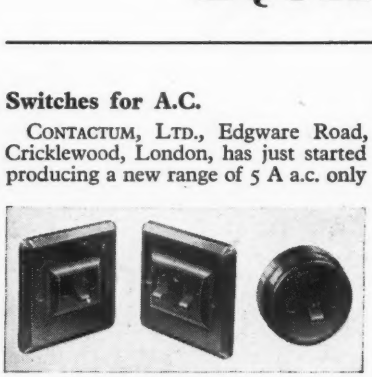
Confidential documents can be completely destroyed by means of the " Shredway " (Stedway Products, Ltd.). Upwards of 50 lb of paper can be dealt with in an hour. The Uno Co., Ltd., display a range of electric branding irons which cover most requirements from branding bacon to marking wooden cases, etc.

The exhibition closes to-morrow at 5 p.m.

NEW ELECTRICAL EQUIPMENT

Switches for A.C.

CONTACTUM, LTD., Edgware Road, Cricklewood, London, has just started producing a new range of 5 A a.c. only



Contactum 5 A switches

switches. These are available as a round surface type or square single or double unit flush type. They are moulded in brown or white plastic material and will fit into shallow plaster depth boxes if necessary.

Stud/Arc Welding Power Unit

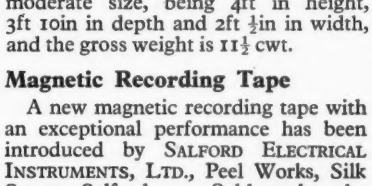
Newly introduced by CROMPTON PARKINSON, LTD., Crompton House, Aldwych, W.C.2, is a transformer-rectifier unit that has been specially developed to meet the requirements of both stud welding and manual arc welding. The unit provides a choice of three outputs—one for stud welding up to ½in diameter studs; another for single operator arc welding with current up to 400 A; and a third for two independent arc welding operators using up to 200 A each.

The new power source consists basically of a 3-phase air-cooled transformer which is suitable for input voltages of 210/250 V and 360/440 V and for operation on a 40/100 c/s supply; two banks of selenium rectifiers which can be operated either in parallel or independently according to the position of the selector switch; and two magnetic amplifiers which facilitate fine control of current when the equipment is used for arc welding. This latter feature, in conjunction with two continuously variable rheostats connected by 20ft of cable, enables the operator to make accurate adjustment of the current at the point of welding.

Also included is a "hot start" feature, i.e., a 25 per cent current increase which occurs momentarily at the commencement of arc welding and provides for easy striking of the arc. All components have been designed electrically and mechanically to withstand extremes of temperature, the unit thus being suitable for use in both tropical and arctic conditions. It is of moderate size, being 4ft in height, 3ft 10in in depth and 2ft ½in in width, and the gross weight is 11½ cwt.

Magnetic Recording Tape

A new magnetic recording tape with an exceptional performance has been introduced by SALFORD ELECTRICAL INSTRUMENTS, LTD., Peel Works, Silk Street, Salford, 3. Sold under the trade name of "Puretone" for 20s a spool, it is a paper-based material with an output and frequency response



Salford magnetic recording tape

which compares favourably with those of plastics tapes costing almost twice as much.

The new tape is sold in lengths of 1,200ft wound on specially designed plastics spools slotted to facilitate rapid threading, and other lengths of tape will shortly be available. The 1,200ft reels give 32 min playing time at 7½in/sec or 64 min at 3¾in/sec.

The coating has an unusually high gloss finish, which, coupled with the addition of a lubricant, greatly reduces the friction and wear on the recorder heads. Intimate contact with the heads and improved high frequency response is thus ensured. On a typical recorder the response curve is substantially flat within ±1 dB over a range of frequencies from 50 c/s to 10 kc/s.

Ground to Air Transmitter

Introduced by EKCO ELECTRONICS, LTD., Ekco Works, Southend-on-Sea, Essex, is their new ground transmitter type CE91, designed for operation on 100-156 Mc/s and to replace the previous transmitter type CE8, whose operating range was restricted to 118-132 Mc/s.

Type CE91 is a 20 W amplitude-modulated transmitter and the operating frequency is crystal-stabilized, being controlled by a quickly exchangeable crystal housed in the front panel of the unit.

Modulation sensitivity is adjustable, maximum sensitivity being of the order of three millivolts at 50 ohms.

Particular attention has been paid in the design to the reduction of spurious emission. Features which contribute to an exceptional performance, in this connection, include a band-pass filter following the crystal oscillator, three tuned circuits at carrier frequency and a low-pass filter in the aerial feeder.

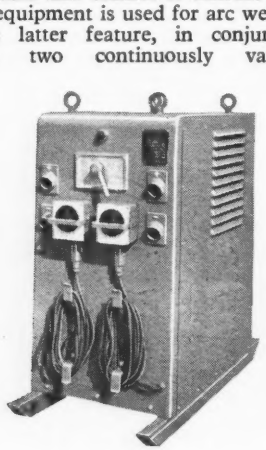
A power unit is included, operating from 200-250 V, 50/60 c/s a.c. mains, and the transmitter, which weighs 75 lb, is constructed to standard 19in rack dimensions.

Metal Detector

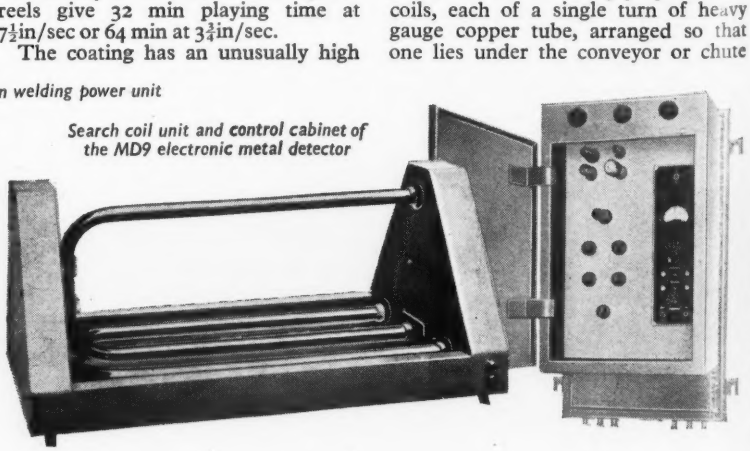
The MD9 electronic metal detector available from METAL DETECTION, LTD., Moseley Street, Birmingham, 12, makes possible a continuous searching of processed material to determine the presence of ferrous or non-ferrous metal.

The complete installation consists of two major items, the search coil unit and the control cabinet, together with the necessary interconnecting cables, etc. The search coil unit consists of two mutually perpendicular coils, each of a single turn of heavy gauge copper tube, arranged so that one lies under the conveyor or chute

Crompton welding power unit



Search coil unit and control cabinet of the MD9 electronic metal detector



carrying the material to be inspected, while the other completely surrounds the conveyor.

The coils are rigidly supported by side plates, from which they are insulated, and the side plates in turn are mounted on a heavy bedplate fabricated from two channel sections and steel plate. The side plates are of box construction to protect the electrical connections to the coils. The whole unit is mounted on shock absorbers, and weighs approximately 500 lb for a 36in conveyor coil.

The control cabinet, which houses the whole of the electronic apparatus and power supply, together with testing controls and the final relay, consists of a sheet steel case hinged to a mounting panel to give access to the rear of the vertically mounted chassis for maintenance. The front panel is also hinged and can be locked to prevent unauthorized interference after adjustment. It is completely sealed to prevent the ingress of dust or moisture and when closed only the signal lamps are visible.

Flashbulbs

The introduction of a new flashbulb is announced by the GENERAL ELECTRIC CO., LTD., Magnet House, Kingsway, London, W.C.2. Known as the G.E.C. No. 1, it is an "M" class bulb and embodies a new form of capless construction, in which the connecting wires are folded upwards along the outside of the base, and are secured at the neck by a fibre retaining ring. Peak flux is reached 18 milliseconds after firing and the total light output is 6,500 lumen-seconds. The price of the bulb is 8d.

The BRITISH THOMSON-HOUSTON CO., LTD., Crown House, Aldwych, London, W.C.2, has introduced a similar bulb—the "Mazda" No. 1. An adaptor is available which will enable it to be used with any flashgun with an A.S.C.C. socket.

Guide numbers for the Mazda No. 3 may be used for speeds up to $\frac{1}{25}$ second with "x" synchronization. The cost of this bulb is also 8d.

Space Heater

A new "Radian" space heater now being manufactured by PEMLEC, LTD., 105, Upper Thames Street, London, E.C.4, has a 750 W "Nichrome" element cast into the actual radiator, and subject to normal usage the heater is guaranteed for ten years. General construction is of aluminium and both floor mounting and wall fixing brackets are provided. Only one model is at present made, but the design is such that several heaters can be butted together to give a greater heat output if required. Overall length is 20in by 12in high and 3½in deep and the weight is 28 lb. Finished in a range of twelve heat-resisting pastel shades, the "Radian" is priced at £7 plus £2 12s 6d purchase tax in the United Kingdom. Towel rails suitable for fitting to the heater are available at extra cost.

Pemlec "Radian" space heater

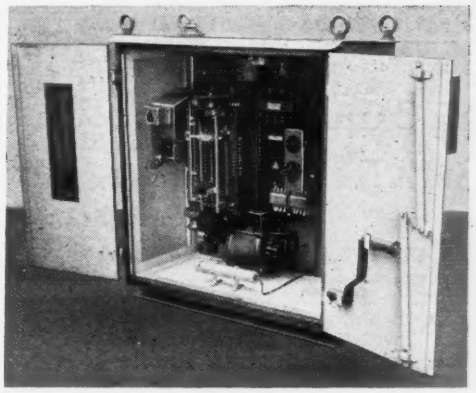
Peak Voltmeters

A "Varley" peak voltmeter for the measurement of transients in electrical circuits has been introduced by OLIVER PELL CONTROL, LTD., Burrage Road, Woolwich. This uses a thyratron and can quickly measure transients from 5 to 35,000 V to an accuracy of 10 per cent. It has the advantage of being easily portable and is sold at £35.

Front view of "Varley" peak voltmeter

On Load Tap Change Gear

The BRUSH ELECTRICAL ENGINEERING CO., LTD., Loughborough, is now producing its own on load tap change gear for three-phase power and regulating transformers. The 33 kV gear is built in two ratings, 250 and 400 A, and is of traditional British design. It is tested under conditions of load which include surge currents and voltages and is suitable for use anywhere in the world and in ambient temperatures from −30 to +40 deg C. It utilizes the reactor principle in the transitional stage from one tapping to another.



Motor control cubicle interior for Brush on load tap change gear

Selector and divertor switches are in separate tanks. The former compartment is separated from that in the main transformer tank so that the oil may be piped through the Buchholz relay to the conservator. A wide range of supply variations is catered for by 21 positions for selection of voltage. Various methods of control are available.

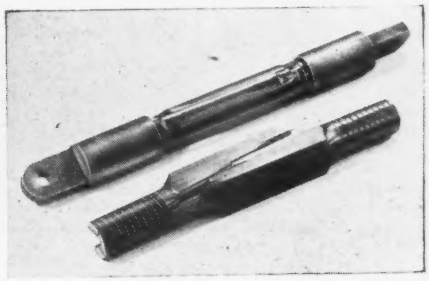
Ballast for Sodium Lamps

A new type of ballast, specially designed to meet the requirements of sodium lamp street lighting installations, is now being marketed by PHILIPS ELECTRICAL, LTD., Century House, Shaftesbury Avenue, London, W.C.2. The unit measures 8⅛ by 4⅝ by 4½in and special features are a marked resistance to corrosion and easy accessibility of terminals. Particular attention has been paid to moisture-proofing. The transformer, designed to operate over a range of 190/260 V, is contained in a die-cast case of silicon aluminium which is finished in black stoved enamel and filled with a hard setting compound, specially selected for its stability at high ambient temperatures. The internal assembly is thus rendered completely moisture-proof. The clearly numbered terminals are deeply recessed and the whole terminal block is designed to eliminate tracking under service conditions.

Tension Insulators

PERMALI, LTD., Gloucester, manufacture insulators of densified laminated material and the illustration shows the strength of their latest product under tension. Measuring 23in long by 3in diameter, the round insulator withstood a load of 37 tons when tested for long shear failure and the square insulator withstood a load of 34 tons. The design load was 22·3 tons. All the fibres were laminated in a lengthwise direction.

Permali tension insulator after test to destruction



Financial Section

STOCKS and SHARES

STOCK EXCHANGE markets are having their first prolonged breather for many a month. Disturbances due to the Bank Rate change having subsided, investors turn to find themselves faced with unpredictables in the shape of the Budget and, perhaps close behind it, a General Election. Investment business has been reduced to small proportions, leaving conditions in which relatively minor transactions are apt to make material differences to quotations. Company news continues to be generally helpful. The majority of the results for 1954 are reflecting the high level of industrial activity, and in many cases are enabling dividends to be improved without overstepping conservative bounds. A.E.I. are following G.E.C. in raising substantial amounts of new capital. Suspension of publication by the London national newspapers served to emphasize the quietude which characterizes most markets round the House.

A.E.I. Capital

About £10¼ million new capital is to be raised by Associated Electrcial Industries through an issue of 5,172,000 ordinary shares at a price of 40s. Of this total, nearly 5 million shares are to be offered by way of rights to existing ordinary stockholders, on a one-for-four basis, and the balance to employees of the group. The news was not unexpected, for the 1954 accounts had disclosed capital expenditure commitments of the order of £7¾ million. Although the price of the existing shares has been on the easy side, the terms of the offer give, of course, substantial prospective value to the "rights," which are worth about 5s per old share with the latter quoted at 65s. In the market, it was thought safe to assume the future maintenance of the current rate of dividend at 14 per cent on the increased capital. Full details of the issue were to be given at the meeting held in the middle of this week.

Brush Results

Brush Group's final dividend restores the total to the rate of 10 per cent which was being paid for some years up to 1951. With sales again over the £20 million mark, the net group surplus is shown in the preliminary statement to have risen by a third to £538,000, which provides practically threefold cover for the amount of the ordinary distribution. Market satisfaction with these results was augmented by the statement that last year's losses in connection with the Indian tube well contracts, were covered by previous provisions, which have not therefore had to be increased following the closure of those operations. The price of the 5s shares, which has been down to 3s at times in the last year or two, hardened to 8s 6d. The yield now works out at about 5⅞ per cent.

Anglo-Portuguese Telephone

Latest results from the Anglo-Portuguese Telephone Co. show that earn-

Week's Price Changes

Company or Board	Nom. Value	Middle price 28th Mar.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1954 Highest	1954 Lowest
Gilt-edged Stocks						£ s d		
Brit. Elec. 1968/73	100	88½		3	3	3 7 9	97	88⅞
Brit. Elec. 1974/77	100	87½		3	3	3 8 6	96½	87¼
Brit. Elec. 1976/79	100	93⅜		3½	3½	3 14 9	101½	93⅞
Brit. Elec. 1974/79	100	102½		4½	4½	4 3 0	111½	103⅞
Overseas Electric Supply								
Calcutta Elec.	£1	21/6	+6d	6†	6†	5 11 6†	24/6	18/7
East African Power	£1	20/6		7	7	6 16 6	23/4	19/6
Nigerian Elec.	£1	24/6	−2/-	10	10	8 3 3	25/-	23/6
Palestine Elec. "A"	£1	22/-		Nil	Nil	—	21/-	16/-
Perak Hydro-Elec.	£1	18/-		6	10	11 2 3	20/-	13/9
Equipment and Manufacturing								
Aberdare Cables	5/-	12/6		25	12½*	5 0 0	14/3	8/1
Aerialite	1/-	5/9		88½	88½	7 13 9*	14/6	10/9
Allen, W. H.	£1	79/6		15	20	5 0 8	78/6	50/-
Aron Elec. Ord.	£1	57/6		20	15	5 4 4	60/-	43/-
Assoc. Elec. Ord.	£1	65/-	−2/6	11½	14	4 6 3	62/6	41/6
Automatic Tel. & El.	£1	70/-		15	15	—	73/-	57/3
Babcock & Wilcox	£1	73/9	−1/3	18	12*	3 5 0	76/3	47/3
Baldwin, H. J.	2/-	4/9		20	20	8 8 6	5/6	3/9
Bakelite	10/-	29/6		12½	16	5 8 6	32/-	23/6
British Aluminium	£1	38/6		12	10	5 4 0	41/-	33/9
B.I. Callender's	£1	47/-	−6d	10	10	4 5 0	52/-	37/9
B.I. Callender's 6% Pref.	£1	25/-		6	6	4 16 0	26/6	24/3
British Thermostat	5/-	22/6		35	27½*	—	28/-	12/-
British Vac. Cleaner	5/-	17/-		25	30	8 16 6	14/6	11/6
Brook Motors	10/-	38/9		20	20*	—	45/6	29/3
Brush Ord.	5/-	8/6	+3d	6	10	5 17 9	8/3	3/6
Bulgin, A. F.	1/-	5/3		30	45	8 11 6	4/3	3/2
Burco	5/-	19/6		35	25*	6 8 3	21/6	12/1
Chloride El. Storage "A"	£1	59/6	−1/3	20	12½*	4 4 0	68/6	46/6
Clarke Chapman	£1	77/6	+1/3	20	20*	5 3 3	73/-	47/6
Cole, E. K.	5/-	19/6	−1/-	25	27½	3 10 6*	20/-	11/6
Cossor, A. C.	5/-	9/6		10	10	5 5 3	11/-	7/-
Crabtree	10/-	31/3		17½	20	6 8 0	32/-	23/9
Crompton Parkinson Ord.	5/-	16/3	+3d	20	20	—	17/9	11/6
De La Rue	5/-	21/-	−6d	Nil	20	4 15 3	24/-	12/3
Decca	4/-	32/6	−1/3	35	56¼*	—	—	—
Desoutter	5/-	27/3		20	25	4 11 9	26/6	16/1
Dewhurst	2/-	7/3		19	24	6 12 6	7/6	5/1
Dictograph Tel.	2/-	6/9		20	20	5 18 6	8/-	5/2
Dubilier Condenser	1/-	4/6		25	25	—	5/3	3/3
E.M.I.	10/-	29/6	−9d	8	10	3 7 9	27/9	11/3
Electrical Components	5/-	15/3		20	20	6 11 3	16/3	10/9
Elec. Construction	£1	32/6		15	15	4 9 0*	35/-	26/6
Enfield Cable Ord.	£1	21/3		5	Nil	Nil	26/3	16/6
English Electric	£1	63/9	−1/3	10	12½	3 18 6	59/-	38/-
English Electric 3½% Pref.	£1	15/6		3½	3½	4 16 9	16/9	15/3
Ericsson Tel.	5/-	36/6	−6d	25†	20†*	2 14 9†	33/9	22/9
Ever Ready	5/-	22/9	−9d	35	40	—	26/3	17/9
Falk Stadelmann	£1	46/3		15	15	6 9 9	49/-	36/6
G.E.C. Ord.	£1	52/6		11½	12½	4 15 3	60/-	37/6
G.E.C. 6½% Pref.	£1	27/-		6½	6½	4 16 3	28/9	26/6
General Cables	5/-	16/3	−6d	20	30	9 4 6	18/-	16/3
Greenwood & Batley	£1	55/-		17½	17½	6 7 3	55/-	40/3
Hackbridge Cable	5/-	15/9	+6d	20	20	6 7 0	15/9	11/3
Hackbridge & Hewittic	5/-	24/6		20	25	5 2 0	25/-	16/10
Hall Tel. Acc.	10/-	13/3	+1/-	10	10	7 11 0	13/-	10/6
Heatrae	2/-	4/3	+3d	12½	12½	5 17 9	5/6	4/-
Henley's	10/-	19/3	+3d	10½	10½	5 9 0	22/-	15/6
Holophane	5/-	17/6		20	25	7 2 9	18/-	13/3

* After capital bonus. † Free of income tax.

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.

ings continue to respond appropriately to the successive infusions of fresh capital into the expansion of the business. The rate of progression during 1954 produced an improvement of the order of 50 per cent in the net surplus, which provides a satisfactory margin for the maintenance of the ordinary dividend, on increased capital, at the now customary 8 per cent. The same rate has been paid since many years before the war, but shareholders have had recurrent opportunities for raising the effective return by way of subscriptions to new issues on bonus terms. Another "rights" issue of shares, in the proportion of one new share for ten old, is said to be under consideration by the directors.

in Electrical Investments

Company or Board	Nom. Value	Middle price 28th Mar.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1954 Highest	1954 Lowest
Equipment and Manufacturing—continued.						£ s d		
Hoover	5/-	44/6	−1/6	45	70	7 17 3	51/-	26/3
I.C.I.	£1	41/6	−6d	13	15	3 12 3°	43/6	26/6
Intl. Combustion	5/-	25/-		20	25	5 0 0	30/-	14/6
Johnson & Phillips	£1	46/3	−9d	15	15	6 9 9	52/6	45/6
Lancashire Dynamo	£1	56/3	−1/3	12½	14	4 19 9	59/6	43/-
Laurence, Scott	5/-	15/9		15	20	3 3 6°	4/9	7/-
Lister, R. A.	£1	31/6		12	9·3°	5 14 6	33/-	22/6
London Elec. Wire	£1	51/-x.r.		10	12½	4 18 0	54/-	38/-
Lucas, J.	£1	42/6	−1/9	10·8	7½°	3 10 6	49/-	25/3
Marryat & Scott	2/-	9/6		22½	25	5 5 3	9/6	5/11
Mather & Platt	£1	58/-	−1/6	15	13·4°	—	53/-	32/-
Metal Industries	£1	32/3	+6d	12	9	5 11 6	42/3	29/6
Midland Elec. Mfg.	£1	45/-		15	10°	4 9 0	43/9	31/6
Morphy-Richards	4/-	27/-	−6d	40	35°	5 3 9	27/6	11/4
Murex	£1	52/-		15	15	5 15 6	57/-	49/-
Newman Ind.	2/-	2/9		10	10	—	2/6	2/-
Oldham & Son	1/-	3/6		17½	17½	5 0 0	3/4	2/5
Parnall (Yate)	5/-	10/3		6	8	3 18 2	11/-	4/3
Parsons, C. A.	£1	58/9		12½°	7½°	2 11 0	60/-	38/1
Plessey	10/-	62/6	+1/3	30	20°	3 3 9	64/-	37/10
Pye Deferred	5/-	31/3	−9d	20	20°	3 4 0	37/-	15/7
Revo	10/-	13/-		27½	9°	6 18 6	20/3	14/-
Reyrolle	£1	92/6		12½	13½	3 0 0	92/6	66/-
Rheostatic	4/-	16/3	+9d	20	22½	5 10 9	15/9	11/-
Richardsons Westgarth	5/-	13/9		15	15°	5 9 0	12/3	6/6
Scottish Cables	4/-	20/-		20	27½	5 10 0	21/9	12/1
Smith (England), S.	4/-	16/-	−3d	15	17½°	4 7 6	17/6	7/8
Southern Areas	£1	28/-		6	7½	5 7 3	32/6	17/6
Strand Elec.	5/-	9/9		17½	17½	8 19 6	10/3	8/3
Sturtevant	5/-	22/6		18·1†	18·9°†	—	22/9	14/6
Sun. Elec.	£1	33/9		15	15	8 17 9	33/9	27/6
Switchgear & Cowans	5/-	15/-		10	20	6 13 4	13/7	9/9
Taylor Tunnicliff	5/-	13/3		12½	15	5 13 3	12/4	10/7
T.C.C.	10/-	45/3		30	25°	5 8 0	41/3	21/3
T.C. & M.	£1	37/6	+6d	10	8½°	4 10 9	37/6	30/3
Telephone Mfg.	5/-	9/-		10	10	5 11 0	9/6	7/6
Thorn Elec.	5/-	28/9	−1/3	12½	20	3 9 6	30/6	13/3
Thornycroft	£1	39/-		15	15	—	39/6	26/6
Tube Investments	£1	77/6		15	17½	4 10 3	81/3	60/3
Vactric	5/-	13/9x.c.		Nil	10	—	—	—
Veritys	5/-	7/-	−6d	10	12½	8 18 6	10/6	5/-
Walsall Conduits	4/-	50/-		70	70	—	52/6	44/-
Ward & Goldstone	5/-	37/-	−1/9	45	50	—	43/6	21/-
Watford	2/-	7/-	+3d	25	22½°	—	7/3	4/7
Westinghouse Brake	£1	93/9		16	18	3 16 9	86/3	60/9
West, Allen	5/-	12/6	−6d	15	17½	—	19/6	12/7
Wolf Electric	5/-	19/-		17½	20	5 5 3	17/6	11/-
Trusts, Transport and Communications								
Anglo-Am. Tel.: A. Ord	100	78½		6	6	7 12 9	89½	80
Ord.	100	50		3¾	3¾	7 17 6	55½	52/-
Anglo-Portuguese	£1	22/6		8	8	7 2 3	25/9	21/-
Brit. Elec. Traction: Def. Ord.	5/-	20/-		35	50	—	24/-	13/-
Cable & Wireless: Ord.	£1	42/6		9	10	4 14 3	42/9	26/2
4% Loan	100	97½		4	4	4 2 0	98½	95½
Calcutta Trams	£1	21/-	+6d	2½†	6†	5 14 3†	24/6	17/1
Cape Elec. Trams	£1	17/-		5½	7	8 4 9	17/6	12/4
Marconi Marine	£1	35/-		10	10	5 14 3	35/-	27/6
Oriental Tel Ord.	£1	100/6	−9d	16	16	—	101/3	82/6
Telephone Props.	£1	80/-	−2/6	—	—	—	92/6	74/6
Telephone Rentals	5/-	10/-		10	10	5 0 0	11/-	9/-

Taylor Tunnicliff

The 5s ordinary shares of Taylor Tunnicliff (Electrical Industries) have remained well supported since the declaration of the single annual dividend of 15 per cent for 1954, which compares with payments of (or equivalent to) 12½ per cent on the two previous occasions. This increase results from an improvement in the net distributable profit from £156,000 to £163,000, of which the net preference and ordinary distributions together absorb under £56,000. At 13s 3d the shares now offer a yield of 5·7 per cent. Regarding prospects, the report refers to labour shortages, but also to satisfactory order books. The annual meeting is being held next Monday.

Automatic Telephone

Among the many company results expected to make their appearance during the coming month, those of the Automatic Telephone and Electric Co. are awaited with particular interest. Expectations may be judged to be confident from the fact that although the price of the £1 ordinary shares has receded to some 8s below the recent best, the yield is still only about 4½ per cent on the basis of last year's total 15 per cent dividend. That rate of distribution has been unchanged for four years, and on the last occasion was covered almost five times over by the net earnings of the year. A 10 per cent scrip issue last June left the total of reserves well in excess of issued capital. The level of expectations generally in this section of the market was raised last month on the strength of the Ericsson Telephone Co.'s results.

English Electric Earnings

One of the present causes for unease in investment affairs is the latest round of industrial wage increases, and the effect which this must have in raising, firstly, the inflationary pressure of consumer demand, and, secondly, the costs of production, both to the detriment of export trade. On the latter point, Sir George Nelson's calculations given to the English Electric Co.'s annual meeting are making a deep impression in many quarters. Speaking in terms of percentage earnings on turnover, he reckoned that while the figure narrowed from 6·2 to 5·9 per cent between 1953-54, it would be reduced again to only 2·4 per cent (at existing prices) by the rise in costs resulting from the general increase of wages. He concluded that the company obviously could not continue to trade on such a basis, so that prices would have to be increased.

REPORTS and DIVIDENDS

The Brush Group, Ltd. — A preliminary statement of the results for 1954 shows that the group sales of products amount to £21,054,069, as compared with £20,845,701 for 1953. The profit before provisions for taxation and Indian tube well contract losses is £1,221,576 (against £884,231). Taxation absorbs £691,544, leaving a net balance of £530,032 (against £322,230), to which is added £17,536 releases from taxation provisions of previous years. The net profit attributable to Brush Group, Ltd., is £537,991, which with £349,216 brought in, makes £887,207 available. General reserve receives £334,596 and it is proposed to pay a final dividend of 7 per cent on the ordinary stock, making 10 per cent for the year. For the previous year a single payment of 6 per cent was made. The balance carried forward is £333,509. The directors state that the losses incurred on the Indian tube well contracts (£177,490 net) have been covered by the provision made in previous years, and it has not been necessary to make any further provision following closing down of the group's Indian tube well operations.

Associated Electrical Industries, Ltd., announces that it has received Capital Issues Committee consent to the issue of 5,172,413 ordinary shares of £1 each for cash at 40s per share, which will bring the total issued ordinary capital up to the authorized amount of £25,000,000. Of these shares approximately 4,957,000 will be offered to existing ordinary stockholders (including those holding stock arising from the Siemens exchange) by a rights issue on the basis of one new share for every complete £4 stock held. The remaining balance of some 215,000 shares will be offered to the employees of the A.E.I. group of companies at the same price.

Clarke, Chapman & Co., Ltd.—The annual general meeting was held on 23rd March. In his statement, Mr. J. B. Woodeson (chairman) said that the electrical side of the Marine Department continued to be very active, and new developments included an electric winch which gave controlled lowering, thus removing the need for a foot brake. Apart from normal business they had on order specialized mechanical handling equipment for land purposes. So far as complete boiler installations were concerned, they had commissioned plant having a total capacity of 2½ million lb/hr. These figures included the first of nine boilers for Stella generating station. Other installations completed included four units for Brunswick Wharf station, each of 320,000 lb/hr and two units for the Belfast power station, each of 180,000 lb/hr. Orders for the year remained at a good level. These included additional B.E.A. contracts and five boilers for the N.C.B. having a capacity of 750,000 lb/hr. A further extension to the fabricating shop was being made. They had continued to expand their overseas contracts. The Canadian office was well established and had made considerable progress. The Indian market continued to be difficult, but they were making good progress. A fair share of orders was being booked from Continental countries.

Charles Clifford, Ltd.—The accounts for 1954 show a consolidated trading profit of £176,428, as compared with £29,228 for the previous year, to which is added £150 income from investments. Taxation requires £97,611, leaving a net profit of £78,967 (against £3,303). With £75,158 brought in the balance available is £154,125. Reserves receive £49,000 and it is proposed to pay a final dividend on the ordinary stock of 10 per cent (against 8½ per cent), making 14 per cent for the year (12½ per cent). The balance carried forward by the parent company and its subsidiaries is £75,149.

In his review of the year Mr. E. A. Norton (chairman) says that the prices of base metals have fluctuated considerably and in particular the price of prompt copper on the London Metal Exchange rose from £235 10s per ton at the commencement of the year to £292 at the end of the year, and has recently attained a new high peak of £361 per ton.

The Superheater Co., Ltd.—The profit for 1954, after taxation of £292,334, is £268,750, as compared with £220,493 for 1953. To this is added unrequired tax provision of £5,000 and £77,619 brought in, making £351,369 available. It is proposed to pay a final dividend on the ordinary and "A" ordinary shares of 20 per cent and a bonus of 10 per cent, making 40 per cent for the year on capital increased by a 50 per cent scrip issue. The distribution for 1953 on the smaller capital was also 40 per cent. The balance carried forward is £86,419.

The Pirelli-General Cable Works, Ltd., is to capitalize £1,000,000 by a scrip issue to members in the proportion of one "A" £5 share for every "A" share held and one "B" £5 share for every "B" share held. The General Electric Co., Ltd., holds 50 per cent of the capital of the company, with the remaining 50 per cent jointly held by Pirelli Holdings, S.A., and Pirelli, Ltd.

G. D. Peters & Co., Ltd., report a net profit for 1954 of £54,253, as compared with £75,065 for 1953. The figure is struck after providing £39,750 for taxation, less previous year's taxation reserves no longer required of £16,294. It is proposed to pay a final dividend of 3⅛ per cent, making 5 per cent for the year. The year's distribution is paid on capital as increased by a three-for-one bonus issue, and compares with 20 per cent for the previous year.

The Anglo-Portuguese Telephone Co., Ltd., in a preliminary statement, reports that after charging capital issue expenses of £55,098, the net profit for 1954 is £322,538, as compared with £216,222 for the preceding year. General reserve receives £150,000 and it is proposed to pay a final ordinary dividend of 5 per cent, making 8 per cent for the year on capital increased by a rights issue to ordinary and "A" ordinary holders. The dividend for 1953 on the smaller capital was also 8 per cent. An unchanged dividend of 8 per cent is proposed on the "A" ordinary capital. The directors have under consideration a further one-for-ten rights issue of 280,500 ordinary shares to ordinary and "A" ordinary holders, subject to Treasury permission.

A. H. Hunt (Capacitors), Ltd.—The preliminary statement for the year ended 31st December shows a group profit of £43,029. To this is added proportion of loss of the Canadian subsidiary applicable to minority interests of £11,159; making £54,188 as compared with £52,693 for 1953. The figure is struck after deducting £86,192 for taxation. Reserves receive £35,000 and it is proposed to pay a final dividend of 20 per cent, making 27½ per cent for the year on £165,000 capital. For the previous year the distribution on £145,000 capital was 25 per cent. The balance carried forward in the accounts of A. H. Hunt (Capacitors) is £41,136 (against £44,730 brought in), and in the accounts of the United Kingdom subsidiary £991 (£1,166).

The Canadian subsidiary's accounts are for the period October, 1953, to 31st December last. At 31st December, 1953, this subsidiary had not effectively commenced to trade and comparable figures for the year to 31st December, 1953, relate only to A. H. Hunt (Capacitors) and the United Kingdom subsidiary.

New Companies

L. Glaser & Co., Ltd.—Registered 22nd February. Capital £5,000. Repairers and manufacturers of and dealers in all kinds of electrical and scientific instruments, electrical machinery and goods, etc. Directors: L. Glaser and M. Glaser. Regd. office: 96-100, Aldersgate Street, E.C.1.

Bentley & Clough (Pudsey), Ltd.—Registered 23rd February. Capital £1,500. Electrical engineers and general electrical installation contractors, etc. The permanent directors are: B. Clough (managing director) and Mrs. Clarice Clough. Regd. office: Tannery Yard, Lowtown, Pudsey, Leeds.

Transtherm, Ltd.—Registered 23rd February. Capital £1,000. Manufacturers, wholesalers, distributors and

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Financial Section (*continued*)

importers of and dealers in electrical goods, including condenser cores, dynamos, armatures, etc. Regd. office: 149, Scraptoft Lane, Leicester.

Suez Contractors (Electricity), Ltd.—Registered 24th February. Capital £100. To operate under contract with H.M. Principal Secretary of State for the War Department, or any other Minister or Department of H.M. Government, public utility installations, services and works of all kinds in the Suez Canal Zone, etc. The first directors are not named. Solicitors: Slaughter & May, 18, Austin Friars, E.C.2.

Increases of Capital

Neptric, Ltd.—Increased by £90,000, in £1 ordinary shares, beyond the registered capital of £10,000.

Abbott & Timbrell, Ltd.—Increased by £5,000, in 1,000 ordinary and 4,000 redeemable cumulative preference shares of £1 each, beyond the registered capital of £3,000.

Fel-Electric, Ltd. — Increased by £18,000, in £1 ordinary shares, beyond the registered capital of £2,000.

Southern Instruments, Ltd.—Increased by £50,000, in £1 ordinary shares, beyond the registered capital of £50,000.

Bankruptcies

H. Freeman, Keepers Cottage, St. Mary's, Uplyme, near Lyme Regis, Devon, manufacturer of electrical and mechanical equipment, and lately residing at 7, Cobb Road, Lyme Regis, and "Waterside," Uplyme.—Receiving order made 11th March on a creditor's petition.

W. R. Eagle, lately carrying on business at 10, Houghton Chambers, 1, Houghton Place, and residing at 70, Eaton Gardens, Liverpool, electrical contractor.—Last day for receiving proofs for dividend 1st April. Trustee, Mr. E. S. Browne, 41, North John Street, Liverpool, 2.

F. R. A. Lock and **V. C. Lock,** trading as Locke Brothers, at Union Street, Stourbridge, electrical engineers.—Last day for receiving proofs for dividend 4th April. Trustee, Mr. R. K. Clark, Somerset House, 37, Temple Street, Birmingham, 2, Official Receiver.

Liquidations

Modern Teleservice, Ltd., radio and television dealers.—Winding up voluntarily. Liquidator, Mr. A. T. Eaves, 47, Mosley Street, Manchester, 2, appointed 14th March.

Cox's Radio & Electrical Co., Ltd.—Meetings of members and creditors on 25th April at the offices of Lucas, Beardsmore & Co., 1, Islington Row, Birmingham, 15, to receive an account of the winding-up by the liquidator, Mr. E. F. Beardsmore.

NEXT WEEK'S EVENTS

Organizers of electrical functions are advised to make use of the "Electrical Review" clearing house, Room 231, Dorset House, Stamford Street, London, S.E.1, to ascertain that proposed dates for their functions do not clash with others already arranged

Monday, 4th April

BIRMINGHAM.—James Watt Institute, Great Charles Street, 6 p.m. I.E.E. South Midland Centre. "Automatic Circuit Reclosers," by G. F. Peirson, A. H. Pollard and N. Care. (Joint meeting with the Supply and Utilization Group.)

GREAT MALVERN.—Winter Gardens Restaurant, 7.15 p.m. I.E.E. South Midland Centre, Worcester and Malvern district meeting. "Recording and Reproduction of Sound," by J. Moir.

ILFORD.—The Angel Hotel, 8 p.m. A.S.E.E. North-East London Branch. "The Electrical Contractors' Association and the rest of the Industry."

LEICESTER.—Demonstration Theatre, Electricity Offices, Charles Street, 7 p.m. Leicester Electrical Society. "Electrical Energy from the Wind," by E. W. Golding.

LIVERPOOL.—At the Royal Institution, Colquitt Street, 6.30 p.m. I.E.E. Mersey & North Wales Centre. Annual general meeting. "Special Effects for Television Studio Productions," by A. M. Spooner and T. Worswick.

LONDON.—At the Geological Society, Burlington House, W, 5.30 p.m. Society of Engineers. "Civil Engineering Works at Castle Donington Power Station," by J. T. Edwards.

MAIDSTONE.—Wig & Gown Hotel, 7.30 p.m. I.E.E. district meeting. Annual general meeting, followed by an informal discussion.

NEWCASTLE-UPON-TYNE. — King's College, 6.15 p.m. I.E.E. North-Eastern Radio & Measurements Group. Annual general meeting, followed by "Thermionic Valves of Improved Quality for Government and Industrial Purposes," by P. Welch and W. W. Wright.

Tuesday, 5th April

BELFAST. — Sir William Whitla Hall, Queen's University, 8 p.m. I.E.E. Northern Ireland Centre. Faraday Lecture: "Courier to Carrier in Communications," by T. B. D. Terroni.

EDINBURGH.—Carlton Hotel, North Bridge, 7 p.m. I.E.E. South-East Scotland Sub-Centre. "The Electrification of the Manchester-Sheffield-Wath Lines, Eastern and London Midland Regions, British Railways," by J. A. Broughall and K. J. Cook.

ELTHAM. — Congregation Church Hall, Court Road, 8 p.m. A.S.E.E. South-East London Branch. Films, or "New Cable Development."

HAMMERSMITH. — Windsor Castle Hotel, 134, King Street, 7.30 p.m. A.S.E.E. West London Branch. "Modern Lift Practice," by S. T. Elvey.

LONDON.—Savoy Place, 5.30 p.m. I.E.E. Measurements and Radio Sections. "High Speed Electronic-Analogue Computing Techniques," by Dr. D. M. MacKay. (Joint meeting.)

At the Royal Society of Arts, John Adam Street, 7 p.m. Incorporated Plant Engineers, London Branch. "The Application of Gas Turbines to Industrial Duties," by G. B. R. Feilden.

MANCHESTER. — Engineers' Club, Albert Square, 6.15 p.m. I.E.E. North-Western Centre. "Electrical Energy from the Wind," by E. W. Golding.

PORTSMOUTH. — "The Air Balloon," 598, Commercial Road, Mile End, 7.30 p.m. A.S.E.E. Portsmouth Branch. "Industrial Lighting."

SHEFFIELD. — Royal Victoria Hotel, 7.30 p.m. Junior Institution of Engineers, Sheffield & District Section. Presidential address: "Engineering in the Twentieth Century," by Prof. S. J. Davies.

YORK.—Royal Station Hotel, 7 p.m. I.E.E. North Midland Centre. "The Possibilities of a Cross Channel Power Link between the British and French Supply Systems," by D. P. Sayers, M. E. Laborde and F. J. Lane.

Wednesday, 6th April

EDINBURGH.—12, Rothesay Place, 7 p.m. I.E.S. Edinburgh Centre. Annual general meeting and films.

GLASGOW.—39, Elmbank Crescent, 7 p.m. I.E.E. South-West Scotland Sub-Centre. "Aluminium-Sheathed Cables," by P. M. Hollingsworth and P. A. Raine.

LEICESTER.—College of Art & Technology, The Newarkes, 6.30 p.m. Incorporated Plant Engineers, Leicester Branch. "Use of Electrical Equipment in the Hosiery Industry," by E. W. Freeman.

Grand Hotel, 6.30 p.m. Institution of Heating and Ventilating Engineers, East Midlands Branch. Annual general meeting and installation of chairman, Mr. H. W. Candy, also John Hughes prize night and social evening.

LONDON.—At the Institution of Electrical Engineers, Savoy Place, 5 p.m. Institution of Post Office Electrical Engineers, London Centre. "Regional Problems in the Provision and Maintenance of V.H.F., U.H.F. and S.H.F. Radio Links," by F. Moxon.

MIDDLESBROUGH.—Cleveland Scientific & Technical Institution, 6.30 p.m. I.E.E. Tees-Side Sub-Centre. "Safety in the Use of Portable and Transportable Electrical Equipment in Industry," by J. W. Bunting.

NEWCASTLE-UPON-TYNE. — Liberal Club, Pilgrim Street, 6.15 p.m. I.E.S. Newcastle Centre. Annual general meeting.

NORTHAMPTON. — College of Technology, 7.15 p.m. Northampton & District Electrical Association. "Application of Magnetic Devices," by J. E. Apted.

PRESTON.—Chamber of Commerce, 49a, Fishergate, 7.30 p.m. A.S.E.E. Preston Branch. "Power Factor Improvement," by T. S. Smith.

STAFFORD.—English Electric Co.'s Lecture Room, Salt Avenue/Sabine Street, 7.15 p.m. I.E.E. North Staffs. Sub-Centre Students' Section. "Eddy Currents in Electrical Machine Conductors," by A. H. Klotz.

SWANSEA.—S. Wales Electricity Board, The Kingsway, 6.30 p.m. I.E.S. Swansea Group. "Black Light—Its Effect and Applications," by H. L. Privett.

Thursday, 7th April

BRISTOL.—I.E.E. Bristol Students' Section. Visit to B.B.C. Studios, Whiteladies Road, at 7.30 p.m.

CARDIFF.—S. Wales Electricity Board, The Hayes, 5.45 p.m. I.E.S. Cardiff Centre. "Black Light—Its Effect and Applications," by H. L. Privett.

CROYDON.—Café Royal, 8 p.m. A.S.E.E. South London Branch. "Some notes on Electrical Safety," by H. W. Swann.

NOTTINGHAM.—E.M.E.B., Smithy Row, 6 p.m. I.E.S. Nottingham Centre. "Compromise in Lighting Fittings Design," by J. Studholme.

NEW PATENTS

Electrical Specifications Recently Published

The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (2s 8d each including postage) will be obtainable after 4th May from the Patent Office, 25, Southampton Buildings, London, W.C.2.

1949

30626. British Communications Corporation, Ltd., and Heftman, T. S.—Frequency changers for radio receivers. 28th February, 1951. (729111.)

1950

4757. Electric & Musical Industries, Ltd. —Electrical phase-shifting or frequency changing arrangements. 26th February, 1951. (729112.)

27017. Autophone, Ltd.—Automatic telephone exchanges. 6th November, 1950. (729031.)

28958. Hydropress, Inc.—Electric switch actuated by the passage of articles. 27th November, 1950. (729033.)

1951

17498. Smit & Co.'s Transformatoren-Fabriek N.V., W.—Electrical controllers. 24th July, 1951. (729428.)

20605. Reyrolle & Co., Ltd., A.—Arc chutes for airbreak electric circuit breakers. 28th November, 1952. (729429.)

22508. Radio Corporation of America.—Electronic character selecting and/or printing apparatus. 26th September, 1951. (729206.)

24584. British Thomson-Houston Co., Ltd.—Electric discharge devices. 1st October, 1952. (729432.)

27779. Philips Electrical Industries, Ltd. —Cathode-ray tubes and apparatus embodying them. 27th November, 1951. (729127.)

1952

1277. British Thomson-Houston Co., Ltd. —Laminar flow buckets for elastic-fluid turbines. 16th January, 1952. (729312.)

1904. Electrolumination, Ltd.—Electric discharge tubes for advertising signs and the like. 22nd January, 1953. (729130.)

2507. British Thomson-Houston Co., Ltd. —Alternating voltage regulators. 30th January, 1952. (729131.)

3007. Gilfillan Bros., Inc.—Radar system. 5th February, 1952. (729442.)

3376. Centre National de la Recherche Scientifique.—Power supply circuits. 8th February, 1952. (729444.)

4140. Klangfilm Ges.—Electric film driving apparatus. 15th February, 1952. (729313.)

5380. Sucal, Ltd., Suchy, C. T., Richards, H. E. G., McAuley, D. J., and Ferrer, H. J. —Electrical resistance elements. 29th May, 1953. (729447.)

7381. Standard Telephones & Cables, Ltd.—Method of forming composite metal coatings on refractory metal. 21st March, 1952. (729449.)

8000. Standard Telephones & Cables, Ltd.—Electrodes for electron discharge devices and methods of making same. 28th March, 1952. (729450.)

9376. Fox, P. X.—Variable electrical resistances and potentiometers. 14th July, 1953. (729451.)

10522. Phoenix Rubber Co., Ltd.—Electrically conductive material. 9th July, 1953. (729321.)

13268. Philips Electrical Industries, Ltd. —Devices for generating ultra-short waves by velocity modulation. 26th May, 1952. (729144.)

13297. General Electric Co., Ltd., Cornell, W., and Harrison, W. J. D.—Telephone type switch mountings. 18th March, 1953. (729046.)

13313. Sunbeam Corporation.—Electric dehorner and means for converting it into a soldering iron. 26th May, 1952. (729216.)

14651. Electrical Apparatus Co., Ltd.— Electromagnetic contactors. 10th June, 1953. (729218.)

16352. Auto-Lite Battery Corporation.— Electric storage batteries. 28th June, 1952. (729465.)

16888. Telefonaktiebolaget L. M. Ericsson.—Electron tube. 4th July, 1952. (729468.)

17576. Coldair, Ltd., and Saunders, N. F. T.—Refrigerators. 13th July, 1953. (729224.)

18422. Painter Bros., Ltd., and Nock, J. L.—Pole and like structures for the support of electric transmission lines and other purposes. 9th July, 1953. (729471.)

19932. Metropolitan-Vickers Electrical Co., Ltd.—Electrically operated hoists, winders and the like. 24th July, 1953. (729474.)

20456. Allis-Chalmers Manufacturing Co. —Gas cooled dynamo-electric machine. 14th August, 1952. (729231.)

21163. Susstrunk, R.—Electric discharge lamp arrangement. 22nd August, 1952. (729333.)

21590. General Electric Co., Ltd.—Electrical apparatus for effecting frequency compression of speech or other intelligence. 26th August, 1953. (729055.)

22170. Westinghouse Electric International Co.—Thermo-responsive a.c. instruments. 3rd September, 1952. (729477.)

22319. Electro-Snap Switch & Mfg. Co. —Electric snap-action switch. 5th September, 1952. (729478.)

22847/9. Hivac, Ltd.—Cold cathode gas-discharge tubes. 15th July, 1953. (729480/1.)

22967. Philco Corporation.—Cathode-ray tube apparatus. 12th September, 1952. (729237.)

23628. Murphy Radio, Ltd.—Radar systems. 21st September, 1953. (729239.)

23866. General Electric Co., Ltd., and Dale, S. H.—Magnetic amplifiers. 23rd September, 1953. (729240.)

24058. British Thomson-Houston Co., Ltd.—Apparatus for controlling the angular rotation of electric motors. 17th September, 1953. (729159.)

26107. Standard Telephones & Cables, Ltd.—Combined television receiver and v.h.f. broadcast receiver. 17th October, 1952. (729443.)

26662. Electricité de France.—Methods and apparatus for frequency multiplying. 23rd October, 1952. (729065.)

27202. British Insulated Callender's Cables, Ltd.—Manufacture of electric resistors. 28th October, 1953. (729167.)

28639. Brennan, J. B.—Closure terminal and mounting constructions for electrical devices housed in containers. 13th November, 1952. (729494.)

29230. British Thomson-Houston Co., Ltd.—Radio receiver circuits. 3rd December, 1953. (729498.)

30741. Revo Electric Co., Ltd.—Cookers or refrigerators. 30th November, 1953. (729346.)

32242. Naamlooze Vennootschap Philips' Gloeilampenfabrieken. — Apparatus for measuring heights or distances by reflection of radio waves. 19th December, 1952. (729509.)

32755. Western Electric Co., Inc.—Pulse counting apparatus. 24th December, 1952. (729172.)

1953

723/4. Hollins, J. R.—Electric flasher device. 9th January, 1953. (729249/50.)

849. Leece-Neville Co.—Electrical generating system. 12th January, 1953. (729512.)

1100. Philips Electrical Industries, Ltd.— Electromechanical resonators. 14th January, 1953. (729176.)

1780. General Electric Co.—Sweep yoke assemblies for cathode-ray tubes. 21st January, 1953. (729515.)

4982. Standard Telephones & Cables, Ltd.—Impulse coincidence circuit. 23rd February, 1953. (729257.)

5109. Westinghouse Electric International Co.—Fluorescent screens. 24th February, 1953. (729521.)

6016. Bush Signs, Ltd.—Electric glow-discharge apparatus shaped and arranged as signs or indicators. 21st January, 1954. (729363.)

8616. Avery, Ltd., W. & T. (Schenck Maschinenfabrik Ges., C.).—Device for the generation of electric alternating currents by means of non-reacting photo-electric scanning of rotating bodies. 28th March, 1953. Addition to 721856. (729368.)

10430. Philips Electrical Industries, Ltd. —Electric pulse selectors. 16th April, 1953. (729373.)

12119. Western Electric Co., Inc.—Voice-frequency signalling systems. 1st May, 1953. (729261.)

12909. Standard Telephones & Cables, Ltd.—Multi-position electrical contactors. 8th May, 1953. (729187.)

14522. Soc. d'Applications des Machines Motrices.—Electric push-button switches of the snap-action type. 22nd May, 1953. (729266.)

16125. Emag Elektrizitäts Ges.—Roller contact arrangements for mechanically-driven rectifiers or other rotating-contact electric apparatus. 11th June, 1953. (729192.)

16893. British Insulated Callender's Cables, Ltd.—Clamping device for a cable. 18th June, 1954. (729268.)

16896. General Electric Co.—Electronic control circuits. 18th June, 1953. (729386.)

18592. Radio Corporation of America.— Colour television synchronizing circuits. 3rd July, 1953. (729391.) 18593. Colour television. 3rd July, 1953. (729271.)

19259. Communications Patents, Ltd.— Electrical computing apparatus. 10th July, 1953. (729395.)

19870. International Business Machines Corporation.—Electronic counter. 17th July, 1953. (729274.)

20357. Philips Electrical Industries, Ltd.— Switching circuits for pulse-loading a source of electrical energy. 22nd July, 1953. (729539.)

22615. General Electric Co.—Amplifier limit circuits. 17th August, 1953. (729107.)

25042. Standard Telephones & Cables, Ltd.—Electric wave filters employing waveguides. 10th September, 1953. (729405.)

25048. Allmanna Svenska Elektriska Aktiebolaget.—Arc-extinguishing arrangement for compressed air circuit breakers. 10th September, 1953. (729280.)

25799. Arrow Electric Switches, Ltd.— Interlocking mechanism for electromagnetic switches. 18th September, 1953. (729406.)

28167. Philips Electrical Industries, Ltd. —Inductors for inductive high-frequency heating. 13th October, 1953. (729109.)

30065. Welwyn Electrical Laboratories, Ltd., and Browning, J.—Electrical resistors. 30th October, 1953. (729411.)

30768. Philips Electrical Industries, Ltd. —Radar relays for transmitting radar images. 6th November, 1953. (729288.)

33508. British Thomson-Houston Co., Ltd.—Electric pulse gating circuits. 2nd December, 1953. (729293.)

36373. Belling & Lee, Ltd.—Plug and socket electrical connectors. 31st December, 1953. (729296.)

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses

Ashington (Northumberland).—12th April. U.D.C. Electrical installation in 36 houses on the Beamsley Terrace housing site. Surveyor, Council Offices.

Australia.—28th April. Sydney County Council. 33 kV submarine cable. (E.S.B. 6036/55. Ten/13064.)*

Belfast.—12th May. Municipal Electricity Department. H.p. pipework equipment for second extension, Belfast West power station. (See this issue.)

Birmingham.—25th April. City Corporation. Electrical installation in Garrett's Green Lane Fire Station, Sheldon. (See this issue.)

Canada.—2nd May. Department of Agriculture, Prairie Farm Rehabilitation Administration Engineering Services. Deep well pumps and prime movers. (E.S.B. 6181/55. Ten/13055.)*

Chester.—11th April. City Corporation. Electrical installation in College of Further Education. (See this issue.)

Ecuador.—11th April. Empresa Electrica Zamora S.A. Hydro-electric substation and transmission lines for Loja. (E.S.B. 6241/55. Ten/13087.)*

Edinburgh.—North of Scotland Hydro-Electric Board. 33 kV and 11 kV overhead lines, etc., Strathearn-Kinross Distribution. (See this issue.)

India.—12th April. Madhya Pradesh Electricity Board, Nagpur. One 5,000 kVA power transformers and two 2,000 kVA transformers. (E.S.B. 6452/55. Ten/13116.)* 15th April. 11 kV pins and strain insulator sets. (E.S.B. 6451/55. Ten/13118.)* 18th April. 11 kV cables and cable boxes. (E.S.B. 6453/55. Ten/13117.)* 27th April. 11 kV switchboards, l.v. switchboards and accessories. (E.S.B. 6363/55. Ten/13120.)*

29th April. Directorate General, Supplies and Disposals, New Delhi. Auxiliary equipment for Maithon power station. (See this issue.)

Kuwait.—26th April. Government Department of Electricity. Water chilling plants and air cooling units. (E.S.B. 6054/55. Ten/13079.)* 10th May. Miscellaneous electrical materials. (E.S.B. 6056/55. Ten/13085.)* 17th May. Water chilling plant, etc. (E.S.B. 6057/55. Ten/13080.)* 28th June. Air cooling sets. (E.S.B. 6063/55. Ten/13097.)*

Portuguese East Africa.—15th June. Direccao dos Servicos dos Portos, Caminhos de Ferro e Transportes. Sixty-three items of electrical equipment including 50 circuit breakers, 100 fluorescent tubes, cable and switches. (E.S.B. 6558/55. Ten/13149.)*

Salford.—30th April. City Corporation. Street lighting equipment. (See this issue.)

Seaton Valley (Northumberland).—9th April. U.D.C. Electric coppers and fires for 30 houses to be built on the Murton Grange estate, Shiremoor. T. W. Burgess, Council Offices, Seaton Delaval.

South Africa.—14th April. Union Tender and Supplies Board, Pretoria. Electronic test equipment. (E.S.B. 6318/55. Ten/13099.)* 21st April. Two 100 kVA, 11 kV/380 V transformers, main switchboard, capacitors and distribution material. (E.S.B. 6611/55. Ten/13135.)*

20th April. Stores Department, South African Railways, Johannesburg. One electrically heated, horizontal, heat treatment furnace. (E.S.B. 6380/55. Ten/13113.)*

Southern Rhodesia.—15th April. Government Central Mechanical Equipment Department. Twenty-six tachographs for use with motor vehicles with 12 V electrical systems. (E.S.B. 6933/55. Ten/13204.)*

15th April. Federation of Rhodesia and Nyasaland. Ministry of Posts. Automatic telephones. (E.S.B. 6880/55. Ten/13222.)*

Turkey.—1st May. Purchasing and Contracting Officer, Allied Land Forces, South Eastern Europe, P.K.527, Izmir. Two 125 kVA and one 26·5 kVA generating sets. (E.S.B. 5970/55. Ten/13050.)*

United States.—12th April. U.S. Bureau of Reclamation, Denver, Colorado. One 2,400 V metal-enclosed, indoor type motor control equipment assembly for Hanover No. 2 pumping plant, Missouri River Basin project. (E.S.B. 5891/55. Ten/13094.)* 19th April. One 30-40 MVA three-phase auto-transformer for the Gila substation. (E.S.B. 6171/55. Ten/13095.)*

12th April. City of Seattle, Lighting Department. Generator voltage switchgear and bus connections and generator neutral grounding reactor for Ross power-house. (E.S.B. 6182/55. Ten/13066.)*

19th April. City of Seattle Department of Finance. Three 30-50 MVA, 230/115 kV single-phase power auto-transformers. (E.S.B. 6440/55. Ten/13148.)*

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).

ORDERS PLACED

Brigg (Lincs).—Street lighting installation (£4,010).—British Thomson-Houston Co.

Chester.—Housing Committee. Recommended. Extension of contract for electrical installation in houses at Blacon to cover 150 houses in scheme 25 (£3,387).—Engineering Service Installation.

Middlesex.—County Council. Education Committee. Recommended. Installation of electricity at the Edmonton (Croyland) Secondary Modern and Primary Schools (£2,883).—J. H. Plant.

Penrith.—Highways Committee. Recommended. Electric lighting of trunk roads (£4,799).—Tele-Electrical Services.

Spenborough.—U.D.C. 71 Class "A" sodium lighting installations on trunk road A.62.—Cohen Bros. (Electrical).

Tynemouth.—Corporation. Electrical installation in the Monkhouse Primary School (£2,424).—Bonham Electrical Co., North Shields.

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors.

Aberdeen.—Infants' school, Mastrick; J. A. O. Allan, architect, 10, Bon Accord Square.

Annfield Plain.—Conversion of Market Hall into theatre; U.D.C. surveyor, Stanley, Durham.

Barrow-in-Furness.—Dwellings (98), North Walney estate; borough surveyor.

Beeston (Notts).—Secondary modern school; T. Bow, Lamartine Street, Nottingham.

Biggleswade.—Fire station on the Stratton House estate (£18,000); S. V. Goodman, county architect, Shire Hall, Bedford.

Bishop Auckland.—Conversions at Castle Lodge to form departmental offices for U.D.C.; J. Ford, surveyor, 50, North Bondgate.

Blackburn.—Operating theatre for Queen's Park Hospital; Manchester Regional Hospital Board, Cheetwood Road, Manchester.

Bury St. Edmunds.—Houses (44), Howard estate; borough surveyor.

Carlisle.—Stores, Milbourne Street, for T. Graham and Son; Graham and Roy, architects, 6, Paternoster Row.

Consett.—Proposed church; A. Rossi, architect, 15, Melbourne Street.

Dagenham.—Dwellings (68), Auriel Avenue; borough engineer.

Chemical plant building; May & Baker, Ltd., Rainham Road South.

Darlington.—Four-storey block of laboratories, etc., for College of Further Education (£150,000); borough architect.

Devon.—Secondary schools at Ivybridge (£134,000) and Ashburton (£79,000); county architect, 97, Heavitree Road, Exeter.

Downham.—School, Launcelot Road; Bridgwater & Shepheard, architects, 42, Bruton Place, Berkeley Square, London, W.1.

Dudley.—Dwellings (160), Saltwells estate; borough architect.

Laboratories and offices, Baginton; Harry Ferguson Research, Ltd., Fletchamsted Highway, Coventry.

Eastleigh.—Old people's home (£41,300); county architect, The Castle, Winchester.

Edmonton.—Two-storey block of factories on the industrial estate at Claverings (£82,000); borough engineer, Town Hall, London, N.9.

Enfield. — Central library extensions (£29,000); council surveyor.

Eston.—Dwellings (150), Teesville estate; U.D.C. surveyor.

Gateshead. — Crematorium (£50,000); borough engineer.

Glastonbury.—Works extensions; Clark, Son & Morland, Ltd., Northover Road.

Gosport.—Houses (204), Rowner estate; borough surveyor, Town Hall.

Grantham.—Secondary modern school (£140,250), for Kesteven County Council; county architect, Sleaford, Lincs.

Grimsby.—Houses (104), Scartho estate; J. V. Oldfield, borough surveyor.

Hayle.—Secondary school in St. George's Road; county architect, County Hall, Truro.

Hornchurch.—St. John's C.E. Church; E. F. Starling, architect, 6, Queen Anne's Gate, London, S.W.1.

Houghton-le-Spring.—Workshops and fire rescue station at New Herrington Colliery; N.C.B. Building Department, Philadelphia, Co. Durham.

Community centres, Houghton, Fence Houses and Barnwell estate and houses (160), Shiney Row; U.D.C. surveyor.

Kingston-on-Thames. — Showrooms and offices, High Street; C. & A. Modes, Ltd., North Row, London, W.1.

Leeds.—Two hostels for the blind on sites at Moortown and Seacroft, for Blind Welfare Committee; city architect, Priestley House, Quarry Hill, 9.

London.—Office building, Dover Street, Mayfair; Seifert & Seifert, architects, 28, Great Ormond Street, W.C.1.

Warehouse and offices, Woolwich; D. T. Harris & Sons, 22, Wellington Street, S.E.18.

Seven four-storey workshop blocks on the Long Street site, Shoreditch (£172,440); L.C.C. architects' department, County Hall, Westminster Bridge, S.E.1.

Margate.—Dwellings (66), St. Peter's Road and Park Road; borough surveyor.

Factory extension; Lines Bros., Ltd., Rovex Works, Ramsgate Road.

Middleton.—Proposed additional swimming bath at Fountain Street; borough surveyor.

Milford Haven.—Dwellings (96), Gellyswick estate; U.D.C. surveyor.

Newcastle-on-Tyne.—Three blocks of flats in Hill Street and houses (26) in Armstrong Road and on the Fergusons Lane estate; city architect, 18, Cloth Market.

Newton Abbot.—Bus station, Kingsteignton Road; Devon General Omnibus Co., Ltd., Newton Road, Torquay.

Norfolk.—Secondary modern schools at Newlyn and Wroxham; chief education officer, Stracey Road, Norwich.

Northampton.—Factory, Dallington Fields industrial estate; Saxone Shoe Co., Ltd., Titchfield Street, Kilmarnock.

North Riding.—Old people's home, Thornaby; H. J. Knowles, county architect, County Hall, Northallerton.

Peterborough. — Eastholm Secondary Modern School (£138,000) for Joint Education Board; city engineer's dept. Bridge Street.

Peterlee (Co. Durham).—Church (£32,000); Cordingley and McIntyre, architects, The College, Durham.

Port Talbot.—Houses (200), Sandfields; borough surveyor.

Rowley Regis.—Factory extensions; Biddle & Edwards, cabinet makers, Tividale Street, Tipton.

Sale.—County primary school, Sale East (£48,364); J. G. Kellett, director of education, City Road, Chester.

Salford.—Works extensions; British Steam Specialities, Ltd., Oldfield Road.

Sheffield.—Factory on the Arundel Street/Sidney Street site; Morris Wilkinson & Co. (Nottingham), Ltd., loom furniture manufacturers, Victoria Works, Basford, Nottingham.

Southampton.—Weston Park Girls' Secondary School; Howard V. Lobb, architect, 20, Gower Street, London, W.C.1.

Stockton-on-Tees.—Workshop and offices, Dog Hill Farm site for J. H. Shouksmith and Son, Ltd.; Biscomb and Perrey, architects, Minster Yard, York.

Sunderland. — Four-storey maisonnettes, three-storey flats, houses for old people, etc., Lawrence Street area; borough architect.

R.C. church and presbytery, Ryhope Road; S. W. Milburn and Partners, architects, 9, The Esplanade.

West Bromwich.—Factory, Lyttleton Hall estate; H. Richards & Sons, Ltd., 10a, Albion Street, Smethwick.

York.—Second section of scheme for technical college at Dringhouses (£165,150); E. Firth, city architect, 8, St. Leonard's Place.

Decorative Fluorescent Lanterns at Plymouth

Royal Parade, in the new city centre of Plymouth, is a spacious thoroughfare 150ft wide between building lines. It is distinguished by the modern architecture of the new buildings, the design of which has been co-ordinated by the city architect, Mr. H. J. W. Stirling, A.R.I.B.A., to impart an appearance of planned and harmonious dignity. In calling for a lighting scheme for Royal Parade, and for Armada Way, which runs into it, the city architect required lanterns which would be in keeping with their surroundings as well as providing the optical efficiency necessary for illuminating this exceptionally wide thoroughfare. The lanterns chosen were specially designed by the General Electric Co., Ltd. Those in Royal Parade each accommodate twenty-four "Osram Natural" 2ft 40 W fluorescent tubes, of which sixteen are vertical and eight are horizontal in a radial arrangement at the top of the lantern. The Armada Way lanterns house eight vertical tubes only. Because of the wide expanse of the footpath and flower beds on the south side of the Parade, there is additional lighting for pedestrians on this side from thirteen matching lanterns on 15ft concrete columns, in which the light source is a group of eight "Osram" tungsten lamps burning horizontally.

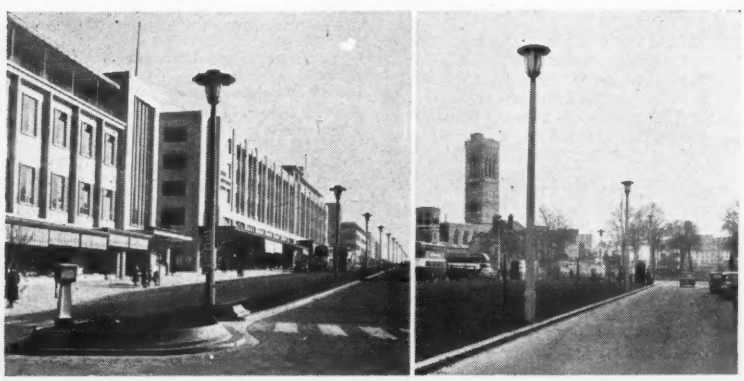
Both fluorescent lantern designs consist basically of a glazed metal framework built round a central barrel. The metalwork is copper, finished bronze, and the eight vertical side panels are glazed with Morocco glass. An octagonal top portion housing the radial tubes in the Royal Parade lanterns has white flashed opal glass. These lanterns are 4ft high and 4ft 3in in diameter.

The vertical tubes are mounted in pairs on vitreous enamel reflectors, to the back of which the gear is attached. One side panel of the lantern can be opened and, after loosening a thumb screw, the complete assembly of reflectors, gear and tubes can be rotated until the unit requiring attention comes into position for removal through the door. Each unit is connected through a flexible lead, a 2-pin plug and socket, and the lantern wiring to a terminal block at the base of the lantern. A complete unit can thus be taken out by undoing two knurled nuts and disconnecting its plug.

The radial tubes are arranged similarly in pairs on removable reflectors complete with gear, but are not rotatable, as any one of four horizontal glazed panels can be removed for access to a particular unit.

The erection and installation work has been carried out by the South Western Electricity Board under the supervision of the manager in Plymouth, Mr. N. Axford.

G.E.C. 24-tube fluorescent lanterns in Royal Parade, Plymouth, and (right) 8-tube lanterns in Armada Way



LIGHTING PLANS

ANDOVER Borough Council is applying for sanction to borrow £43,092 for street lighting.

BANSTEAD (Surrey) U.D.C. has under consideration schemes for the improvement of street lighting at Lower Kingswood (estimated cost £11,020), South East Ward (£3,300), Tadworth (£19,560) and North East Ward (£2,550).

BOURNEMOUTH Highways and Works Committee has recommended that a capital works programme of main road lighting estimated to cost approximately £21,250 shall be carried out in the financial year 1955-56.

DARLINGTON Town Council is seeking loan sanction for £12,630 for improving the lighting in Crown Street, East Street, Horsemarket and Feethams.

Plans are to be prepared for the installation of a new system of street lighting by mercury vapour at FARNHAM (Surrey).

HINCKLEY (Leics.) U.D.C. is to spend £4,986 on replacing gas street lamps with electric lamps and other lighting improvements and additions.

LAMBETH Borough Council is recommended to approve a scheme, estimated to cost £13,299, for the conversion from gas to electricity of side-street lighting in the Ferndale and Town Hall Wards.

REDCAR Town Council is to approach the Ministry of Transport with a scheme for converting the town's street lighting from gas to electricity. The first part is estimated to cost £18,447.